DOCUMENT RESUME

ED 454 842 IR 020 821

TITLE	ICCE/ICCAI 2000 Full & Short Papers (Web-Based Learning).
PUB DATE	2000-11-00
NOTE	540p.; In: Learning Societies in the New Millennium: Creativity, Caring & Commitments. International Conference on Computers in Education/International Conference on Computer-Assisted Instruction (Taipei, Taiwan, November 21-24, 2000); see IR 020 792. Some figures contain very small and illegible type.
PUB TYPE	Collected Works - General (020) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF02/PC22 Plus Postage.
DESCRIPTORS	*Computer Assisted Instruction; Cooperative Learning; *Educational Technology; Elementary Secondary Education; Foreign Countries; Higher Education; *Instructional Design; *Systems Development; *World Wide Web
IDENTIFIERS	Collaborative Learning; Learning Environments; *Web Based Instruction

ABSTRACT

This document contains full and short papers on World Wide Web-based learning from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction). Topics covered include: design and development of CAL (Computer Assisted Learning) systems; design and development of WBI (Web-Based Instruction) systems; application of the Internet to cooperative and traditional learning; a WBI system supporting individual learning styles; a multinational virtual learning community; Internet-based distributed learning; interactive learning systems; collaborative teaching for creative learning; networked constructive CAI (Computer Assisted Instruction) systems; the effectiveness of a Web-based collaborative learning system on mathematics; corporate trainers' experiences with Intranet-based training; building mathematics collaborative learning Web sites; building multi-tier component-oriented multimedia CAI systems; CALL (Computer Assisted Language Learning) in cooperative learning environments; intelligent tutoring systems; constructing an in-service training Web site for teachers; constructing a real-time CAD (Computer Assisted Design) learning system; teaching models in Web-based teacher training; measuring the effectiveness of Web-based learning materials; developing a Web concordance for ESL (English as a Second Language) learners; domain specific information clearinghouses; student learning styles, motivation, learning strategies, and achievement in Web-based learning; a second language online writing system; learner control in technology-mediated learning within a constructivist model; schema theory-based instructional design of asynchronous Web-based language courses; analysis of social discourse in a network-based learning community; the Internet-based educational resources of the U.S. government; and virtual reality. (MES)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 454 842

ICCE/ICCAI 2000 Full & Short Papers (Web Based Learning)

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL HAS
BEEN GRANTED BY

G.H. Marks

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

- ☑ This document has been reproduced as received from the person or organization originating it.
- ☐ Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

IR020821

ICCE/ICCAI 2000

Learning Societies in the New Millennium : Creativity, Caring & Commitments

HOT NEWS

Background
Committees
Call for Papers
Deadlines
Registration
Program
Paper Acceptance
Reviewers
Venue & Travel Info.
Contact Info.
Host & Sponsors
Related Websites
Discussion Board
Proceedings

HOME

Proceedings

Content

▶Full & Short Papers (Web-Based Learning)

A CAL System for Appreciation of 3D Shapes by Surface Development (C3D-SD)
A Comparative Study of Applying Internet on Cooperative and Traditional Learning
A Dynamic WBI System supporting Individual Learning Styles
A European Learning Environment: Reflections on Teaching and Learning in a Multinational Virtual Learning Community
A Framework for Internet Based Distributed Learning
A Java-based Interactive Learning System of Junior High School Level Geometry
A Learner-Centered Navigation Path Planning in Web-based Learning
A Methodology for Learning Pattern Analysis from Web Logs by Interpreting Web Page Contents
A study of collaborative teaching for creative learning in an engineering class
A Study of Networked Constructive CAI System Using Multiplication-Concept of
A Study on the Effectiveness of Web-based Collaborative Learning System on School Mathematics : Through a Practice of Three Junior High Schools
A Survey Study on Corporate Trainers' Experiences, Attitudes, and Perceptions towards Intranet-Based Training
A Virtual Classroom for Algorithms with Algorithmic Support
A Web-based Interactive Exercise System for Learning Mathematical Functions
Adaptive Programming Language Tutoring System on the Web
An Adaptive Navigation Support with Reorganized Learning Resources for Web-based Learning
An Analysis of the Practice of Web-Based Learning in Elementary Schools in Tiwan
An Effectiveness Study of Web-based Application for Mailing List Summary and Review
An Intelligent On-Line Learning System by Combining Assessment and Adaptive Learning
An on-line ITS for elementary algebra
Anatomy on the Cutting Edge: Pre-dissection Lecture-on-Demand at the National University of Singapore
Automated Quantitative Extraction Method of Aesthetic Impression from Color Images using the Tone in the HLS Muncell Color Space
AWETS: An Automatic Web-Based English Testing System

Building Mathematics Collaborative Learning Web Sites
Building the Multi-tier Architecture of Component-Oriented Multimedia CAI Systems on Internet
CAI system generator on web -- using automatic trace recording
CALL with a Web-based Instructional System in Cooperative Learning Environments
CBR-Tutor: A Case-Based Reasoning Approach to an Internet Agent-Based Tutoring System
CedarLearning: The Development of Learner-Centred Environments
Computer-Mediated Language Learning
Construct in-service Training Web Site for School Teachers
Constructing a real-time CAD learning system based on OpenGL in Web-based environment
Design and Evaluation of Constructivist Web-based Instructional Systems
Design and Implementation of Teaching Models in Web-based Teacher Training
DESIGN AND IMPLEMENTATION OF WEB-BASED LEARNING SYSTEM FOR TEACHER-TRAINING PROGRAMME
Designing a Web-Based Action Learning Environment - Integrating Learning and Working in One Environment
Developing a research instrument for measuring the effectiveness of Web-based learning materials
Developing a Web Concordancer for English as Foreign Language Learners
Developing an Effective Web-Based Learning Environment for Overseas Chinese Education
Developing an IT-immersion Environment to Enhance Learning and Teaching in Design and Technology
Developing Web Courses Systematically
Developing Web-Based Language Learning Environment
Development and Evaluation of a CALL System for Supporting the Writing of Technical Japanese Texts on the WWW
Development of a Web System to Support Computer Exercises and its Operation
Development of CAI System with Character Code Discrimination on WWW Environment
Development of Cross-cultural Communication System and Web-based Japanese Education
Domain Specific Information Clearinghouses - A Resource Sharing Framework for Learners
Educational Newspaper Information Gathering Agent for NIE
Empowering Secondary School Teachers to Effectively Exploit Internet Resource for the Enhancement of Teaching and Learning
Examining problems of student teachers to build a web-supported environment
Factors in Web-based learning: student learning styles, motivation, learning strategies, and achievement
Gold Peach Web Community 2000: A Research on Developing Web Based Interactive Learning Environment
Group Composition Methods for Cooperative Learning in Web-based Instructional Systems

Integrating Information Technology with Language Pedagogy for a Second Language Online Writing System
Integrating Web-based Materials into Course Design
Is Everyone On Board: Learning Styles and the Internet
KnowDisLC: A Knowledge Distributed Web-Based Learning Community for University Students
Learner Control in Technology-mediated Learning within a Constructivist Model
LEARNERS' STRUCTURAL KNOWLEDGE AND PERCEIVED DISORIENTATION IN A HYPERMEDIA ENVIRONMENT: THE EFFECTS OF INFORMATION CONVEYING APPROACHES AND COGNITIVE STYLES
Learning Digital Logic Design by Concept Mapping
Learning with Computer Mediated Communication in Remote Offcampus Cross-Cultural Contexts:Bridging the Information Gap
Making Exploration History Interactive for Web-based Learning
Models and Strategies for Promotion of Distance Learning in Primary Schools and High Schools
Multimedia Whiteboard Design in WWW-Based Remote Cooperative Education System
Navigation Script for the World Wide Web
Networked Constructive CAI System Putting Emphasis on Communication and Discussion - An Example of Proportion-concept in Mathematics of Elementary School
Online Education: A Learner-Centered Model with Constructivism
Schema theory-based Instructional Design of Asynchronous Web-based Language Courses
SimPCS: A Web-based PCS Learning Tool
Simulating Engineering Professional Practice Using an Interactive Web-based Resource: A Virtual Engineering Consultancy Company (VECC)
Student use of learning strategies in Web-based courses
Students' Attitude toward WPSS in Supporting Classroom Learning
The analysis of social discourse in a network-based learning community----The GeoSchool Experience
The Application of Scaffording Theory on the Elemental School Acid -Basic Chemistry Web
The Design and Implementation of Automatic Exercise Generator with Tagged Documents based on the Intelligence of Students:AEGIS
The Design of CAI with Thinking Activity to Progress Constructive Teaching - An Example of Division-concept in Mathematics of Elementary School
The Development and Evaluation of a Learning Support System for Converting Web Pages
The Impact of Web-Based Interactive Multimedia on Conceptual Development
THE INTERNET-BASED EDUCATIONAL RESOURCES OF THE U.S. FEDERAL GOVERNMENT
The network learning supported by constructivism
The Production of Web-based Interactive Video From Structured Script

The Rhetoric of the Web. A semiotic approach to the design and analysis of Web-documents
The Status of Cyber University in Korea and its Future Direction
Tracking and Guiding Tools for learning Groups in a Web Collaborative Learning System
TWO TYPES OF VIRTUAL SCHOOL IN INET SUPPORTED BY TEACHER'S GROUP -COLLABORATION TYPE AND LOOSELY CONNECTED TYPE-
Virtual Inhabited 3D Worlds and Internet Based Learning Environments
WALTZ: A Web-based Adaptive/Interactive Learning and Teaching Zone
Web Based Real plus Virtual Observatory Project
Web Speaking: A Language Learning System in the Web
Web-Based Learning Portfolio(WBLP): An Electronic Authentic Assessment Tool on Web
Web-Based Subject-Oriented Learning Program on Geophysics for Senior High School
WWW-Supported Environments for Learning and Teaching Statistics

▲ HOME

A CAL System for Appreciation of 3D Shapes by Surface Development (C3D-SD)

Stephen C F Chan*, Andy Wai, Jean Chow & Vincent T Y Ng
Dept. of Computing, Hong Kong Polytechnic Univ., Hong Kong
*csschan@comp.polyu.edu.hk

A web-based Computer-aided learning system for 3D - Surface Development Module (C3D-SD) has been developed for teaching the appreciation of 3D geometric shapes by unfolding the surface boundary of a solid object into a planar 2D pattern. The problem is similar to the problem of surface development in technical drawing and highly related to the reverse problem of folding a 2D shape into a 3D object, with practical applications in sheet metal work, pattern making, and packaging design. C3D-SD makes extensive use of animation, interactive control by the student, and quizzes to present the material and to engage the students. It makes use of the solid modeling library SML to create 3D solid shapes by Boolean combinations (union, intersection and difference) of primitive shapes, and Java3D for rendering and animation. It includes a Packaging Design Module which builds on the Surface Development module by automatically adding flippers and minimizing the rectangle enclosing the unfolded pattern. This system is the second installment of a series of CAL systems for Three-dimensional Geometry that the authors have been developing.

Keywords: **3D geometry, surface development, animation**

1 Introduction

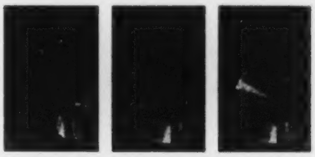
Surface development is an important technique in design. Generally it involves unrolling a curved surface into a planar 2D pattern. Theoretically speaking only certain classes of surfaces are "developable" [Carmo 1976]. If, however (as is the case in many computer graphics systems), curved surfaces are approximated by sets of planar facets, then all curved surfaces can be unfolded into 2D planar shapes, although they may appear to be "unnatural" or "ugly". A related problem is the unfolding of the planar faces bounding a facetted solid object into a planar 2D shape. The inverse of the problem is folding a planar 2D shape into a 3D object, e.g., folded the card-board boxes for hamburgers in fast-food restaurants. These techniques have practical applications in sheet metal work, pattern making, packaging and package design, etc. [Giesecke et al 1997] This paper describes the development of a Web-based computer-aided learning system for teaching the appreciation of surface development/unfolding based on a polygonal representation of solid objects. It is a part of a series of Web-based tools for teaching 3D geometry that our group has been developing. A previous project focussed on sectioning and interactions between some primitive solid shapes was reported in [Chan et al 1999].

Traditional teaching materials on these topics were mainly text based. Better materials have graphics or charts in addition to plain texts. In presenting descriptive topics, this approach is adequate. However, in teaching three-dimension geometry, the two-dimensional and static presentation style is obviously not enough. The use of videos can be effective to some extend but it is still one-way communication and not interactive. A more effective alternative is to use real solid objects to help students visualize 3D shapes. But some objects are difficult to be made, and it is impossible for teachers and students to change the size, scale, shape or appearance of the object quickly.

In contrast to the limitation of 2D materials, videos and real 3D objects, a virtual environment can be a better approach in presenting certain 3D geometry problems. A virtual environment is a computer-generated environment in which 3D or even the forth dimension (time) can be presented through animation. Within the virtual environment, one can change the size, scale, shape or appearance of the virtual object interactively. To have a clearer look, one can zoom into the object. To see the inner structure, one can set part of the object to be transparent. And geometry can be animated by transforming the object over time. And of course, an interactive teaching approach is much better than one way communication in enhancing student understanding. Finally, for purposes of accessibility and distribution, the Web is the ideal environment. These considerations drove the development of this project.

2 Overview of C3D-SD

The main problem tackled by C3D-SD is surface development, as illustrated below in Figure 1. In (a) is shown a solid cone shaped object with the top cut off at an oblique angle. In (b) the surface of the cone is in the middle of being unfolded. In (c) the unfolding is complete. Note that we had tried to keep the unfolded 2D shape connected. As a result, the curved conical surface itself became disconnected (actually connected through a single vertex). It is not difficult to see that it is possible to unfold the surface while keeping the curved conical surface connected.



(a) (b) (c)

Figure 1. Surface development in action.

C3D-SD is organized into three types of activities:

1. Tutorials - Students are guided through demonstrations, including: matching 3D solids to unfolded shapes, animations of unfolding (e.g., of the conical object in Figure 1), animations of folding 2D patterns into 3D solids, adding flippers to unfolded 2D patterns for fastening, reducing the size of the rectangle bounding the unfolded pattern, etc.
2. Free-form exercises - Students are allowed to explore the teaching material on their own. They are provided with numerous opportunities to interact with the teaching material, e.g., creating complex 3D solids by combining primitive shapes, selecting view points, putting different textures on objects, controlling the animation process, etc. The problems are similar to those presented in tutorials. But many more shapes are available for students to experiment with, for self-guided exploration and exercise.
3. Tests - Students can test their understanding of the material through multiple-choice tests. They are asked, e.g., to match an unfolded 2D shape with the solid object, such as illustrated below in Figure 2. If so desired, they can turn to the free-form exercises to explore the test shapes that they have problems with.

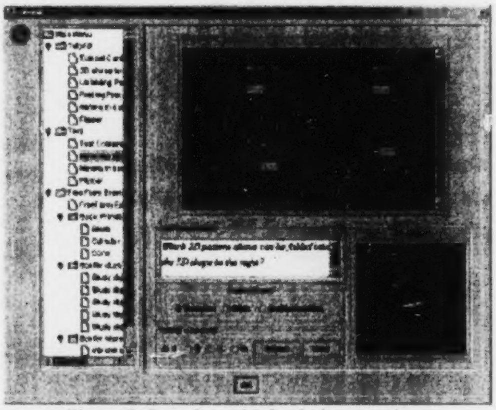


Figure 2. Sample multiple choice question.

The three types of activities are chosen for the following reasons. The tutorials provide core contents to be imparted to the students. The free form exercises allow the students to explore the subject on their own.

Different students with different backgrounds and learning styles benefit from different learning activities, hence both guided and sef-guided types of activities are provided. Finally, tests are developed to gauge the students' grasp of the material. It is expected that C3D-SD can be integrated with an intelligent tutoring system to provide a learning experience more tailored-made for the individual students.
C3D-SD focuses on five types of problems:

1. Matching 3D solid shapes with the corresponding unfolded 2D patterns.
2. Unfolding the surface boundary of a facetted solid and developing curved surfaces.
3. Folding 2D patterns into 3D solid shapes.
4. Simple packaging design: Adding flippers to the unfolded 2D pattern for fastening.
5. Simple packaging design: minimizing the rectangle bounding the unfolded 2D pattern.

3 The 3D Solid Design Module

Java was chosen to develop this system as it is a web-oriented development language and only a Java-enabled Web browser (e.g. Netscape, Microsoft Internet Explorer) is needed to access the Web pages without installing other plug-ins. However, it is difficult to build 3D applications using only the core Java classes. A Java-based high-level programming library, Solid Modeling Library (SML) [Chan et al 1998] is used in C3D-SD for designing 3D solid objects. SML supports the building of 3D solid objects through a set of atomic functions called Euler operators. These functions allow the incremental manipulation of Boundary Representation (B-rep) models, while processing the underlying well-formed data structure. It also supports the creation of solid primitives (block, cylinder, cone, sphere, torus) and Boolean operations (union, intersection, and difference) on solids and transformations (translation, rotation) of solid objects for easy creation of complex 3D solid shapes. For example, a hollow pipe can be created by the differencing (subtracting) a smaller cylinder from a larger cylinder. SML uses a hierarchical half-edge data structure that stores rich information about a solid model [Mantyla 1988], including solid-to-face, face-to-face, face-to-edge, edge-to-edge, edge-to-vertex, and vertex-to-vertex information. The data structure used in SML to represent the surface boundary of solid objects is illustrated in Figure 3.

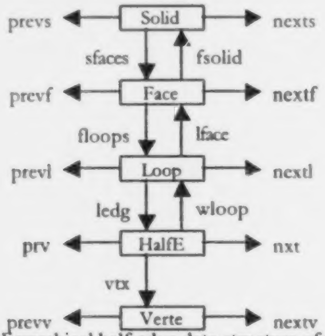


Figure 3. Hierarchical half-edge data structure of SML.

4 Surface Development

The process of surface development or unfolding is illustrated in Figure 4 using a cube as an example. Each face of the cube is coloured differently for easy identification. One might imagine that the unfolding starts by holding the bottom (red) face of the cube fixed to the horizontal plane, and rotating the rest of the cube about the edge linking the red face with the green face until the green face is in the same plane as the red face. This is followed by the blue face, then the yellow, then the light blue, .., and finally the purple, until all faces lie in the horizontal plane.

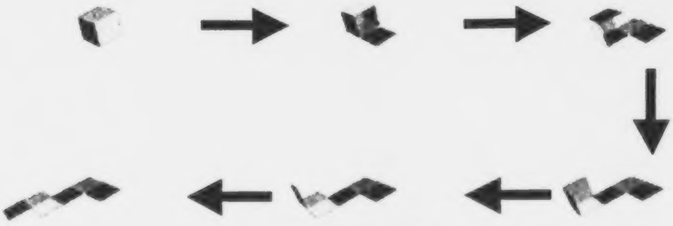


Figure 4. Unfolding a cube.

Sun Microsystems provides the Java3D application programming interface (API) which can be used to develop three-dimensional graphics applications and applets. It gives developers high-level constructs for creating and manipulating polygon-based 3D geometry and for constructing the structures used in rendering that geometry [Sowizral et al 1998, Sun 2000, Brown & Peterson 1999]. It is an object-oriented API, which can be used to construct individual graphics elements as separate objects and connect them together into a tree-like structure called the scene graph. It contains a complete description of the entire scene including the geometric data, attribute information and viewing information needed to render the scene from a particular point of view. Java3D provides a simple and flexible mechanism for representing and rendering scenes with lighting effect but it does not provide high-level construct for creating complicated solid object models. Hence SML was used to create the 3D solids which are subsequently converted into Java3D for rendering and animation.

4.1 Conversion from Solid (in SML) to Surface (in Java3D)

Each face object in SML is converted into a Java3D geometry object by using the information on the vertices of the face. As a result a SML solid object is converted into a group of Java3D geometry objects, each representing a face as illustrated in Figure 5. However, the data structures used to represent objects in Java3D and SML are different, and a conversion process is required to integrate the two systems to take advantage of their respective strengths to produce a more complete solution.

The displayable object in Java 3D is implemented by the Shape3D class. The Geometry and Appearance objects make up a Shape3D object. The Appearance objects controls the outlook of an object, e.g. color, material, etc. The Geometry object contains the vertexes information. We choose triangle as the basic shape in forming a geometry object because it contains the minimum number of vertexes that can form a plane. So that any face shape can be formed by the combination of triangles.

The conversion of an object represented in SML to one represented in Java3D involves 4 steps. Recall that each face in a SML Solid is converted into a Geometry object in Java3D.

1. Find the number of faces in the SML Solid object.
2. For each face, find the number of vertexes and the coordinates of each vertex.
3. Group three vertexes into a triangular strip.
4. Combine all triangular strips to form a Geometry object in Java3D.
5. Each Geometry object will result in a Shape3D object.
6. Group all Shape3D objects to form the representation of the solid in Java3D.

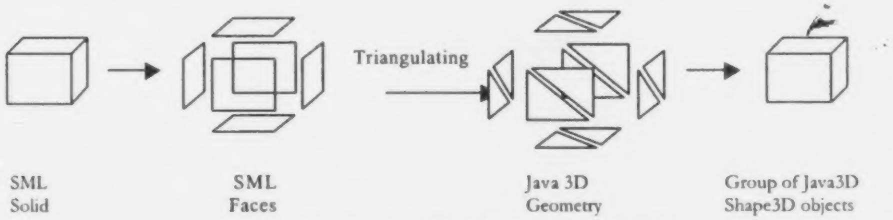


Figure 5. Converting an object from SML into Java3D.

4.2 Unfolding Path

In order to "develop" a surface approximated by a set of polygons, or to unfold the boundary of a solid, one needs to determine a connected path traversing all the faces one at a time. The path for unfolding can be

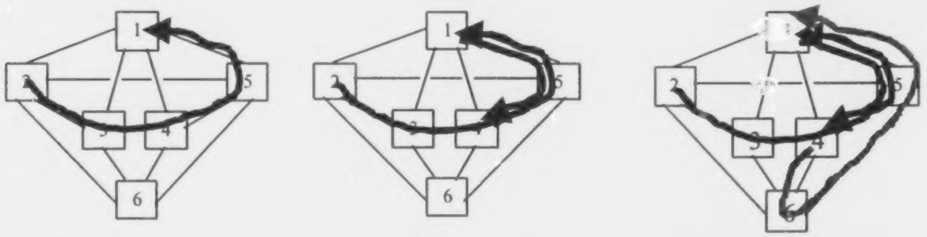
1. specified manually by the student,
2. pre-set in CAL-SD manually by the teacher, or
3. determined automatically by CAD-SD.

Automatic determination of the path for unfolding involves two steps:

- Determine the connectivity between the faces, e.g., in the form of a **graph** whose nodes are the faces, and an edge links a pair of neighbouring faces, and
- Traverse the graph to find the desired connected **path**(s) that visits each face one at a time and each face only once.

As the data structure of SML stores rich information of the complete solid, the connectivity relationships between faces can be easily derived. To derive the path(s) of traversing all faces one and only one at a time is a version of the traveling salesperson problem [Johnsonbaugh 1996]. It is a problem that is known to be hard (computationally expensive) for arbitrary graphs. In our system prototype, we chose to use exhaustive search because of its simple implementation. In future versions we may try to find a more efficient algorithm. In the default version of the algorithm, we simply try to find a solution (any solution) using the well-known **backtrack** algorithm. Firstly, pick up a face arbitrarily. Then, traverse to one of its neighbors. Repeat this process until all the faces have been visited. When a dead-end occurs, it will back track one or more steps to find another possible way (Figure 6). Dead-end means arriving at a face with no un-visited neighbours, while there are still un-visited faces remaining in the graph.

The algorithms implemented in C3D-SD so far traverse the faces of an object in a linear sequence, i.e., the unfolded faces form a linear chain of planar polygons. There are other alternatives, e.g., unfolding in two directions at the same time, resulting a Y shaped chain of polygons, etc. In future versions of the system, we will implement other unfolding algorithms.



(a) Dead-end occurs when traversing 2 ⇨ 3 ⇨ 4 ⇨ 5 ⇨ 1

(b) Backtracking from dead-end to face 4 to find another possible path

(c) Path 2 ⇨ 3 ⇨ 4 ⇨ 6 ⇨ 5 ⇨ 1 is one of the possible paths traversing all the faces one and only one time

Figure 6. Finding a possible path for unfolding the faces of a solid.

4.3 Heuristics for Developing Smooth Surfaces

In SML and in Java3D, as in many computer graphics systems, a curved surface (e.g. conical, cylindrical, etc.) is approximated by a set of planar polygons. If we choose a face' s neighbor in an arbitrary way, a solid may be unfolded into an "ugly" or "unnatural" shape because the set of polygons used to approximate a smooth surface my or may not be unfolded (smoothly) in an appropriate sequence. The left side of Figure 7 shows a cylinder approximated by a total of 22 plane faces (20 for the curved surface and 2 for the top and bottom faces). If we unfold the cylinder arbitrarily, for example, following the path 1-2-3- ...-21-22, may result in the patter in the middle. One of the polygons in the set used to approximate the curved cylindrical surface is disconnected from the other polygons in the set.

We observe, however, that in the set of polygons approximating a smooth curved surface, each polygon shares at least one edge with another polygon in the set, and the included angle between the two polygons is very close to, but just slightly less than, 180 degrees. Taking account of the Smooth Surface Heuristics discussed above, we can try to select the neighbor making the largest angle with the current face, instead of selecting an arbitrary one. Applying this heuristic to the unfolding of the cylindrical solid will result in the developed surface to the right.

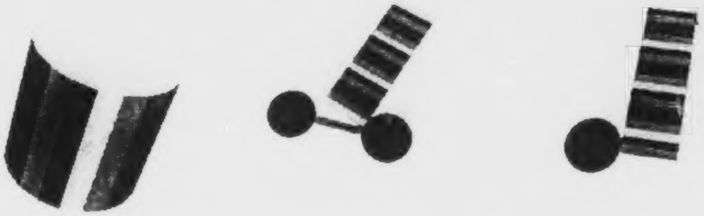


Figure 7. Arbitrarily unfolding the cylinder to the left may result in the pattern in the middle, and applying smooth surface heuristics will result in the pattern to the right.

5 Partially Automated Packaging Design

The design of packaging such as the rectangular boxes used to hold hamburgers at fast food restaurants involves the design of the 2D patterns that can be folded into such boxes. Similar problems exist in sheet metal work and other areas. The surface development/unfolding algorithm discussed above can be used to partially automate such designs.

5.1 Addition of "Flippers"

In addition, one also need to add "flippers" to some of the faces. Flippers are extended faces for putting glue or stickers in order to fasten two faces together when folding the planar 2D shape into a 3D solid shape. We have developed a simple algorithm to determine which edges of the faces of a solid model need to have flippers added. As flippers are used in connecting neighbouring faces, basically, all edges around a face need flippers except:

1. Edges that have been used as axes of rotation during the process of unfolding, i.e., edges between consecutive faces in the connected path for unfolding. (▨ in Figure 8)
2. Edges for which flippers have already created on the opposite face (■ in Figure 8)

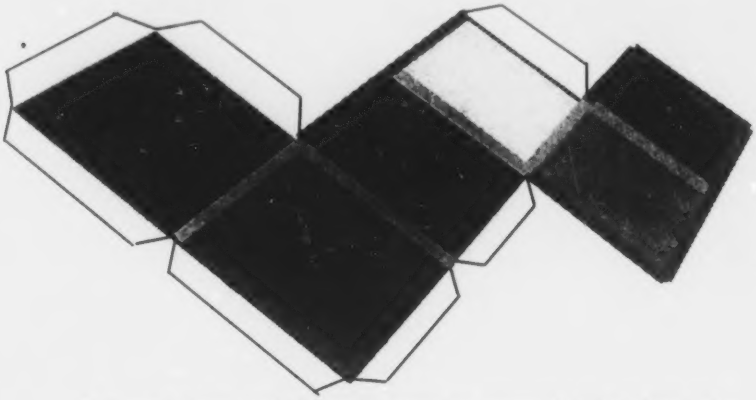


Figure 8. Creation of "flippers" in partially-automated design of packaging.

5.2 Minimizing Bounding Rectangle

The unfolding of 3D shapes are often constrained by certain requirements. For example, in the design of packaging or sheet metal work, the unfolded shape may be the pattern to be cut out of a rectangular sheet, to be folded into the solid shape. In such cases it is desirable to reduce the amount of wastage by making the rectangular sheet required as small as possible. This translates into a requirement to minimize the area of the smallest rectangle enclosing the unfolded planar shape, as illustrated in Figure 9. Smallest rectangle enclosing the unfolded 2D shape. Such constraints may not be easy to satisfy absolutely. However, it is often enough to find a reasonable but not necessarily the perfect solution. In the case of determining a minimum bounding rectangle, it may be sufficient to find a local but not the absolute minimum. A local minimum can be determined by backtracking a few steps from the solution found to determine the set of related solutions and choose the one with the smallest bounding rectangle.

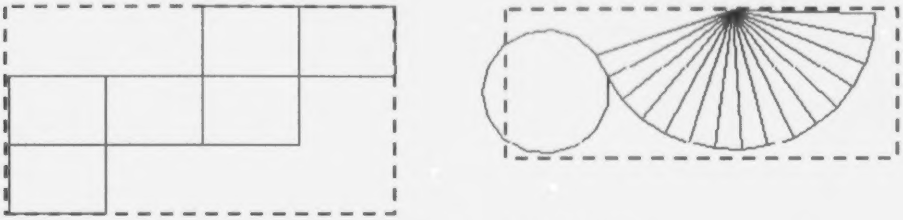


Figure 9. Smallest rectangle enclosing the unfolded 2D shape.

5.3 Some Examples Used in CAD-SD

Many examples of realistic solid shapes have been built into CAD-SD for illustrating and teaching surface development. Figure 10, Figure 11, and Figure 12 show the results of unfolding some common solid shapes, with "flippers" added automatically. For simple solid shapes it is fairly easy to deduce from the unfolded 2D patterns what the original 3D solid shapes are. Some of these are given to the students as exercises.

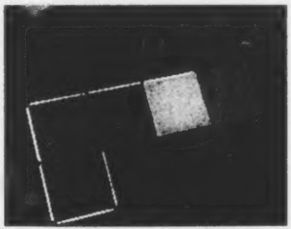


Figure 10. The 2D shape that results from unfolding the cube in a sequence different from that shown in Figure 8. Creation of "flippers" in partially-automated design of packaging., also with flippers added.

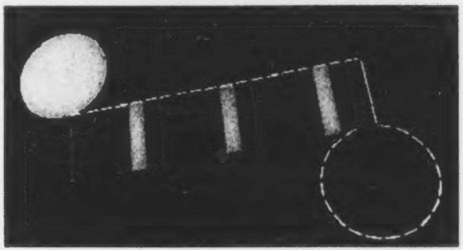


Figure 11. The result of unfolding a cylinder, with flippers added.

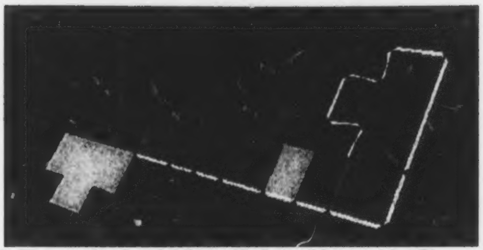


Figure 12. **The result of unfolding a T-shaped box, with "flippers"** added.

6 Conslusion

Using the SML solid modeling system and Java3D surface modeling and rendering system, we have successfully developed the basic structures of a CAL system that makes use of 3D modeling, animation, and interactivity to teach the appreciation of certain class of 3D shapes through surface development and unfolding. We have also shown how the unfolding algorithm can be used to partially automate the design of the 2D patterns used in certain sheet metal work and packaging design problems, by also automating the addition of flippers for attaching neighbouring faces, and reducing the rectangular sheet from which the planar (unfolded) patterns are to be cut out. Based on these basic functions, a comprehensive set of teaching materials can be developed to greatly enhance the degree and interactivity and effectiveness in the teaching of the appreciation of 3D geometry.

Acknowledgement

The work reported in this paper was partially supported by Hong Kong UGC/RGC/CERG grant PolyU 5102/97E.

References

[Brown & Peterson 1999] Brown, Kirk & Peterson, Daniel. *Ready-to-Run Java 3D*, Wiley, 1999.

[Carmo 1976] M P do Carmo. *Differential Geometry of Curves and Surfaces*. Prentice-Hall, 1976.

[Chan et al 1998] Chan, S., Ng, V., and Au, A.. "A Solid Modeling Library for the World-Wide Web", *Computer Networks and ISDN Systems*, Vol. 30, Issue 20-21, Nov. 1998, pp. 1853 – 1863.

[Chan et al 1999] Chan, Stephen, Lui, Kin Ming, Ng, Vincent & Chui, Raymond. "A Java-based Computer-Aided Learning System for 3D Geometry", *Proceedings, The 7th International Conference on Computers in Education*, Volume 1, November 4 – 7, 1999, Chiba, Japan, pp. 1010 - 1017.

[Giesecke et al 1997] Frederick E. Giesecke, Alva Mitchell / Henry Cecil Spencer, Ivan Leroy Hill / John Thomas Dygdon /James E. Novak with Shawna Lockhart. Technical Drawing, Tenth edition (p.626 - 640): Prentice Hall 1997.

[Johnsonbaugh 1996] Richard Johnsonbaugh. Discrete Mathematics, fourth edition (p.304 – 309, p.331 – 336): Prentice Hall

[Mantyla 1988] Martti Mantyla. An Introduction to Solid Modeling (p.161 – 174): Computer Science Press 1988

[Sowizralet al 1998] Henry Sowizral, Kevin Rushforth & Michael Deering. The *Java 3D API Specification*, Addison Wesley, 1998.

[Sun 2000] Sun Microsystems, Inc. *Java 3D 1.1 API Specification*, http://java.sun.com/products/java-media/3D/index.html, 14 April, 2000.

A Comparative Study of Applying Internet on Cooperative and Traditional Learning

Weichung Wang*, Yannjiun Tzeng and Yuan Chen
Department of Mathematics Education, National Tainan Teachers College
Tainan 700, Taiwan
**E-mail: wwang@ipx.ntntc.edu.tw*

The Internet-based cooperative learning has become a new trend in education, thanks to the rapid development of the technologies. This study evaluates the effects of utilizing the Internet on cooperative and traditional learning. Aiming on an elementary school natural science topic, this study compares learning performance of two pupil groups that contains 36 twelve-year-old pupils for each group. We found the learners who adopting Internet-based cooperative learning outperform the other group on Memory-demanding, integration, and deduction type problems. Furthermore, the Internet-based cooperative learning group has uniform performance on the three types problems and is generally more aggressive. In contrast, the Internet-based traditional learning group tends to perform better only on Memory-demanding type problems and has relatively passive learning attitude. Based on the experience, we encourage using the Internet in cooperative learning for nature science. Teachers also need to compose a complete plan and familiarize learners with an Internet browser before conducting the course.

Keywords: **cooperative learning; traditional learning; Internet-based cooperative learning; difference of significance**

1 Introduction

Rapid progress of the Internet has greatly changed the way of teaching and learning. The Internet not only overcomes the space and time limitation of a closed environment such as a classroom, the Internet also contains many useful educational resources that motivate and attract students. This new environment demands teachers to adapt new teaching methods by using applications like World Wide Webs (WWW) and E-mail. Therefore, the means by which teachers efficiently take advantage the new technology is an essential education subject.

While many teachers have started integrating the Internet into their classrooms, little systematical researches has focused on using the Internet in cooperative learning. Aiming to combine the Internet with cooperative learning concept, we conducted this study to (1) evaluate feasibility and efficiency of Internet-based cooperative learning, (2) develop strategies that can help students to learn actively and independently by Internet-based cooperative leaning, and (3) compare students' performance while applying the Internet on cooperative and traditional learning methods.

This study designed a way merging the Internet into a cooperative learning environment. The designed course focused on Sixth grade Natural Science (for twelve-year-old pupils) in Taiwan. Our study demonstrated the feasibility of Internet-based cooperative learning. We showed that pupils leaning in an Internet-based cooperative learning environment can outperform those who learn in an Internet-based traditional learning environment. Pupils' performances were evaluated by questions requiring their problem solving capability in memory demanding, integration, and deduction. All the findings are supported by statistical quantitative analysis results with significant difference.

In other words, this study focuses on the following questions:

(1) What kind of role does the Internet play in Internet-based cooperative learning and Internet-based traditional learning?
(2) Do pupils have enough computer literacy for Internet-based learning?
(3) Is there any learning efficiency difference between Internet-based cooperative learning and Internet-based traditional learning?
(4) If such difference really exists, which one is better?
(5) Do these two teaching methods have significant difference in student's problem solving capability? Especially in the aspect of memory demanding, integral, and deductive ability.

1.1 Literature review

We now survey literatures related to our study.

1.1.1 Using the Internet in learning environment

With the popularity of the WWW, a great deal of interest and enthusiasm has being expressed among teachers concerning the use of the WWW as a learning tool.[2,7] The main reasons are that the Internet offers a new learning environment that is quite different from the traditional classroom, and teachers can utilize Internet resources to enrich their teaching.

The Internet offers a learning environment that can be characterized by the following [6]:
(1) It has no limitation on place or time. That is, students can learn all kinds of knowledge at any place and any time.
(2) It is interactive and flexible. Students can choose different contents based on their learning conditions.
(3) The Internet integrates global educational resources.
(4) Students can communicate and discuss subjects with each other on the Internet. They also benefit from cooperative learning
(5) Multimedia effects of the Internet enhance students' motivation in learning.

In addition, Donald and LeuDeborah [3] suggested instructional strategies including Internet Workshop, Internet Activity, Internet Project, and Internet Inquiry.

1.1.2 Roles of teachers and students in cooperative learning

In order to achieve a better result in the cooperative learning process, teachers and students need to be fully aware of the role they play. Wang [13] claimed that, in most cases, cooperative learning should be practiced by a small group of students. The students' ability to cooperate are emphasized in the learning process. By group discussion, students can learn actively and build their own knowledge. Cooperative learning stresses that students play a major role in all learning activities and learn independently. According to the mission, students do their own literature search and then read, analyze, organize, and experiment with their material. Students establish learning concepts and share what they have learned via discussion with group members. Cooperative learning also emphasizes heterogeneous group learning. Teachers need to understand the profiles, difficulties, and expertise of learning of each student in order to group student in the best way. Therefore, teachers need to be well prepared and have a good plan on course work before performing cooperative learning.[9]

Some authors also pointed out that cooperative learning is more than just having a group of students solve problems in a cooperative way. Most importantly the following factors need to be included in the process of achieving a common goal [14]:
(1) Group members need to understand that they are a part of a team sharing a common goal.
(2) Group members need to realize that the problem is for the whole group and they share the success or failure with the whole group.
(3) Students need to talk to each other and join the discussion after accomplishing the common goal.
(4) Every group member needs to be fully aware of the fact that his or her contribution has a direct effect on the success of this group.

1.1.3 Comparison between cooperative learning and traditional learning

Colonel Paker first introduced the concept of cooperative learning in late nineteenth century. The concept has further become an active research subject in the last three decades. [1] One main topic of this research

field is to compare the efficiency of cooperative learning to that of traditional learning. Many experimental results showed that cooperative learning is superior to tradition learning.[4,5,8,10,11] Actually, Slavin [10] further pointed that:
(1) 63% of studies had showed that cooperative learning is superior to traditional learning,
(2) 33% of studies had showed no significant difference between these two methods, and
(3) 4% of studies had showed that traditional learning is superior to cooperative learning.

1.1.4 The way of communication of traditional learning and Internet-based learning

Advantage of computer network mediated communications can further enhance the advantage of using the Internet in cooperative learning. Traditional learning allows only one-way communication between student and teacher. Tyan and Hong [12] mentioned in their recent study: "The way of communication in traditional learning has many limitations. It has to be simultaneous in space and time; it is only a one-way broadcast communication from teacher to whole students as a group; its messages are is by oral in most cases; special arrangement, such as tape recording, note taking, and etc., are needed to record the teaching material."

In contrast, computer network mediated communications are more versatile. It can be simultaneous or non-simultaneous in space and time. It allows multilateral communications between a teacher and students and between students. In addition to broadcast from a teacher to the whole class, it also allows private dialogue. Finally its messages are textual and graphic information displayed by a computer, which can be automatically stored in a computer.

1.2 Organization of the paper

We state the methodology and the process of the study in the next section. Experimental results are demonstrated and analyzed in Section 3. Findings and inducing suggestions are elaborated upon in Section 4. We conclude the paper and provide further direction in Section 5.

2 Methodology

2.1 The presumptions of this study

We assume that students are capable of using the Internet while engaging in Internet-based learning, and the Internet-based cooperative learning group is trained to have skills for cooperative learning. In addition, a suitable site is designed by teachers based on the learning goal. Teachers needs to be prepared before perform the Internet-based learning.

2.2 Flow chart of this study

Figure1 shows the flow chart designed for this study.

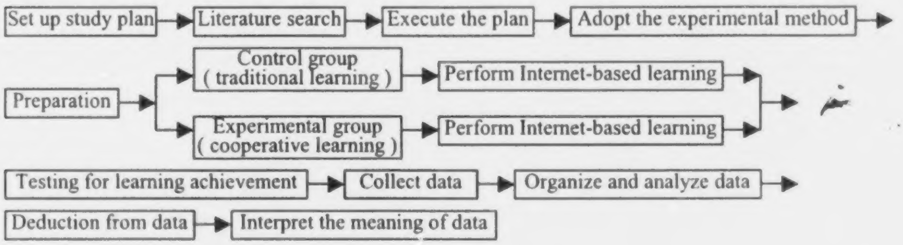

Set up study plan
Literature search
Execute the plan
Adopt the experimental method
Preparation
Control group (traditional learning)
Experimental group (cooperative learning)
Perform Internet-based learning
Perform Internet-based learning
Testing for learning achievement
Collect data
Organize and analyze data
Deduction from data
Interpret the meaning of data

Figure 1. The flow chart for the process in this study.

2.3 The process of this study

2.3.1 The subject of this study

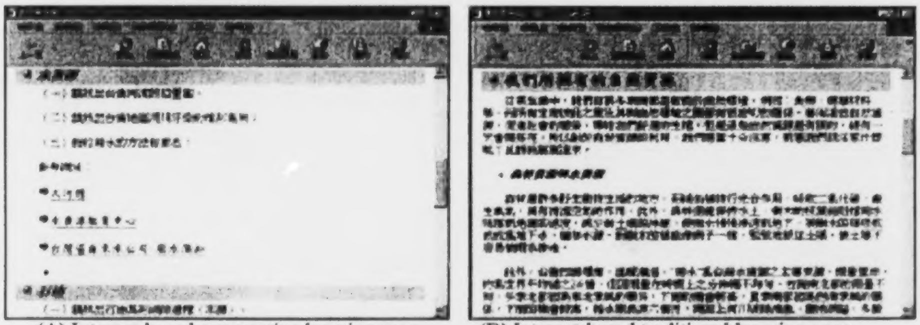
Two Sixth-grade "Computer Experimental Classes" of Hai-Tung Elementary School (Tainan, Taiwan) are the subjects of this study. Both classes have a normal distribution in students' learning capabilities. Each of these two classes has 36 student subjects.

We group the students by the following mean. All 72 students are listed sequentially according to their learning capability. Students with odd numbers are assigned to the experimental group; those with even numbers are assigned to control group. Students in each group are further divided into subgroups. Each subgroup has 3 members who have low, average, and high learning capability respectively.

2.3.2 The tool of this study

In this study, computers are the basic tool for both two groups. For the purpose of this study, a web site has been designed based on the twelfth volume of the nature science textbook for elementary school. Figure 2 shows some snapshot examples of the web. The Internet-based cooperative learning page contains only topics and possible URL links, but the Internet-based traditional learning page describes whole the knowledge for this course. The Internet-based cooperative learning group get knowledge about the topics from relative URLs and discuss with their members. However, the Internet-based traditional learning group only get knowledge from Internet-based traditional learning page. While the learning is proceeding, teachers need to help students to cooperate and make them more aggressive.

The experimental group receives Internet-based cooperative learning; on the other hand, the control group receives Internet-based traditional learning. An "Activity Page" (See Figure 3) is used to evaluate the achievement of these two groups and it contains memory-demanding, integration, and deduction problems that is designed based on the learning goal. For example, we design an integration problem about natural resource recycle to test students' ability to integrate the fractional knowledge thsy learned. The idea of letting student groups browse the Internet according to the "Activity Page" and then discuss and present the findings in a workshop is also suggested by Donald and Deborah.[3]



(A) Internet-based cooperative learning page (B) Internet-based traditional learning page

Figure 2. Web pages for Internet-based learning.

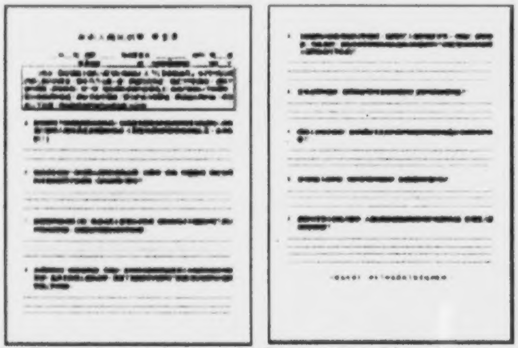


Figure 3. Activity page for Internet-based learning.

2.3.3 Data analysis

Figure 4 shows the flow chart for the data analysis. The data was obtained from the examination given after the learning experiment. The data was analyzed for statistically significant difference of 0.05 and 0.01. In order to investigate students' problem solving capabilities for different types of problems, the examination contains memory-demanding, integration, and deduction problems. We defined these three types of problems as follows:

(a) Memory-demanding type: this kind of problem is given to test students' ability to memorize the fractional knowledge they learned;
(b) Integration type: this kind of problem is given to test the students' ability to integrate the fractional knowledge they learned;
(c) Deduction type: this kind of problem is mainly to test the students' ingenuity and creativity after comprehending the knowledge they learned.

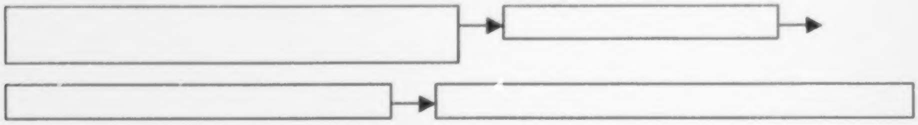
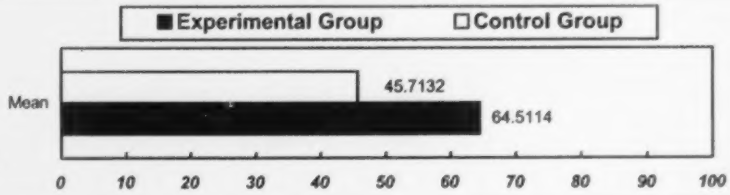


Figure 4. Data analysis flow chart.

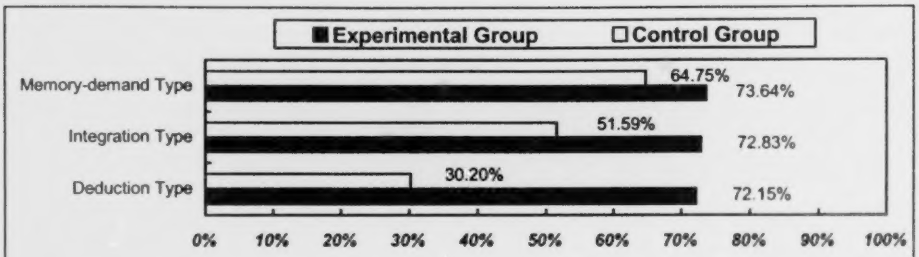
3 Experiment results

Both the experimental group(Internet-based cooperative learning group) and control group(Internet-based traditional learning group) are subjected to have a same examination for evaluation. Figure 5 shows total test scores for experimental group and control group, and Figure 6 shows a comparison on scores of memory-demanding, integration and deduction problems.



item / group	Samples (N)	Mean ($\overline{X}$)	Standard deviation (SD)	t-value	p-value
Experimental Group	36	64.5114	14.6882	4.5540	< 0.01
Control Group	36	45.7132	19.7863		

Figure 5. Total test scores for experimental group and control group.



Problem Type \ Item		Mean	Standard deviation (SD)	t-value	p-value	Ratio of correct answers
Memory-demand	Experimental Group	24.3007	4.0356	1.8285	< 0.05 > 0.01	73.64 %
	Control Group	21.3678	8.7102			64.75 %
Integration	Experimental Group	40.0590	7.4270	5.6315	< 0.01	72.83 %
	Control Group	28.3768	9.9087			51.59 %
Deduction	Experimental Group	7.9370	4.4192	4.589	< 0.01	72.15 %
	Control Group	3.3216	3.6473			30.20 %

Figure 6. Scores on various types of problems for experimental group and control group.

4 Findings and suggestions

4.1 Findings

Based on the data obtained and the observation made during the experimental process, the following conclusions can be drawn. Besides, due to the restriction on experimental samples, the excessive inference should not be draw from these conclusions.

(1) Internet-based learning is feasible in an elementary school nature science course.

This study shows that either Internet-based learning method can fulfill the learning goal after the analysis of examination according to "Activity Page". Most sixth grade students can easily adapted themselves to Internet-based learning environment. Hardware equipment is not an issue in Taiwan, on the other hand. Since the Taiwanese government has greatly prompted information education in recent years, all levels of schools are equipped with personal computers.

(2) There is a significant difference in students' total examination scores for Internet-based cooperative learning and Internet-based traditional learning.

The t-value of this difference is 4.554 that can be regarded as statistically significant at the level of 0.01. Therefore, Internet-based cooperative learning is greatly superior to Internet-based traditional learning.

(3) The Internet-based cooperative learning group has better learning results on Memory-demanding type of problems.

Students in the Internet-based cooperative learning group performed better in this type of problem than those in the Internet-based traditional learning group. The different is considered as level of significance of 0.05, but less than the level of significance 0.01. It means that the learning efficiency of Internet-based cooperative learning is superior to Internet-based traditional learning, but not in a large significance.

(4) On integration type of problems, the Internet-base cooperative learning group significantly outperforms the Internet-based traditional learning group.

Students in the Internet-base cooperative learning group need to piece together information from various Internet resources. During the process of integration, they build new models and images in their minds. By merging new models and images with old knowledge, they can form new knowledge. New and old knowledge is then integrated into a full concept. This is the reason why the Internet-based cooperative group had better learning efficiency on integration type of problems than the Internet-based traditional learning group.

(5) Students in the Internet-based cooperative learning group have higher scores in deduction type of problems.

In deduction type problems, students in the Internet-based cooperative learning group outperformed those in the Internet-based traditional learning group by 72.15% versus 30.20% in the ratio of correct answers. This reflects that students in the Internet-based traditional learning group lack logical inference capability. On the other hand, the Internet-based cooperative learning group had better logical inference ability and more creative ability.

(6) The Internet-based traditional learning group performed best in the memory-demanding problems.

In traditional learning, the teacher delivers teaching material and its highlights directly to students. Since the teacher has organized his material before class, the teaching method is more suitable for Memory-demanding type of problem. This is why students in the Internet-based traditional learning group score higher in memory-demanding problems than other types of problems.

(7) Students in the Internet-based cooperative learning group scored evenly in all kinds of problems.

Students in the Internet-based cooperative learning group score 73.64%, 72.83%, and 72.15% on memory-demanding, integration, and deduction problems. Thus, this teaching method is suitable to all kinds of evaluation methods.

(8) Students in the Internet-based cooperative learning group are more aggressive in learning than those in the Internet-based traditional learning group.

In dealing with problems, students in the Internet-based cooperative learning group acted cooperatively and aggressively in searching for answers using Internet resources. On the other hand, those in the Internet-based traditional learning group are less aggressive in overcoming difficulties, and give up at an early stage.

4.2 Suggestions

(1) Elementary school natural science courses can better utilize Internet resources to perform cooperative learning.

The massive resources on the Internet are an important and attractive factor motivating students to learn actively. Thus, teachers need to better utilize such resources to improve learning efficiency.

(2) During the process of Internet-based cooperative learning, a teacher needs to develop students' capability in cooperative learning.

The success of cooperative learning depends heavily on students' capability in cooperative learning. Teachers thus need to develop students' capability to learn cooperatively during their regular teaching. They should also make students understand the spirit and meaning of cooperative learning which ~~is~~ that each group member is willing to share their knowledge with others.

(3) Before performing Internet-based cooperative learning, teachers need to have a complete plan regarding the learning environment.

An effective cooperative learning relies on teachers' full preparation before the class, which includes: students properly divided into groups; teaching related material, such as web sites; increase initiation factor for cooperation; improve group members' contribution; develop students' ability to browse the Internet; and so on. These entire things require teachers to communicate with their students to reach a consensus before the class.

(4) Both teachers and students need to be aware of the roles they play in Internet-based cooperative learning process.

Though students learn by using Internet resources in Internet-based cooperative learning, the teacher still plays a crucial role. Like a navigator in a voyage, the teacher prevents students from being overwhelmed by the massive information on the Internet and guides them to reach their learning goal according to a series of stages. Students need to have the spirit of a trail-blazer in daring to make all kinds of trial effects. They also need to share the learning experience with others.

(5) During Internet-based cooperative learning, a teacher needs to increase students' consciousness on cooperation.

In cooperative learning, knowledge is obtained through cooperation between group members. Hence, group members should realize that the goal of the group is their own learning goal. Group power can be used to overcome learning difficulties, and develop a learning method that is suitable to the whole group. This allows each group member to experience the joy of learning.

5 Conclusions

This paper describes that cooperative learning and traditional learning can be combined with the Internet in an elementary school nature science course, and the learning efficiency will not be reduced. In addition, Internet-based cooperative learning is greatly superior to Internet-based traditional learning in learning efficiency. Since this paper is the plot study of Internet-based learning, we only focus on the learning efficiency of applying Internet on cooperative and traditional learning. It is likely that future replications of the study will in turn lead to discovery of comparison between other learning methods, such as cooperative learning, traditional learning, Internet-based cooperative learning and Internet-based traditional learning. Furthermore, we intend to develop different teaching strategic to lead students' interaction in the future.

References

[1] Chen, S. J., "The Effects of Pairing Learning Methods and Cooperative Training on Concept Learning", Journal of Pingtung Teachers College, Vol. 11, pp. 25-54, (1998).

[2] Chu, Y. M., "The integration of Internet cooperative learning and traditional instruction", The 7th International Conference on Computer-Assisted Instruction (ICCAI 1998), Kaohsiung, Taiwan, pp. 551-557, (1998).

[3] Donald J. Leu, Jr. & Deborah Diadiun Leu., "Teaching with the Internet: Lessons from the Classroom", Norwood, Massachusetts, 1999 Edition, (1999).

[4] Hooper, S., "Cooperative learning and computer-based instruction", Education Technology Research and Development, Vol. 40, No. 3, pp. 21-38, (1992).

[5] Johnson, D. W., & Johnson, R. T., "Cooperative learning and achievement", In Sharan, S. (Ed.) Cooperative learning: Theory and research, pp. 23-38, (1990).

[6] Lin, C. S., "Computer Network and Education Reform", Friends of Elementary Education, Vol. 49, No. 1, pp. 5-12, (1998)

[7] Oliver, R., Omari. A. & Herrington. J, "Exploring Student Interactions in Collaborative World Wide Web Computer-Based Learning Environment", Journal of Educational Multimedia and Hypermedia, Vol. 7, No. 2/3, pp. 263-287, (1998).

[8] Sharan, S, "Cooperative learning in small groups: Recent methods and effects on achievement, attitude, and ethnic relations", Review of Education Research, (1980).

[9] Slavin, R., "Research in cooperative learning and achievement: What we know, what we need to know", Contemporary Educational Psychology, Vol. 21, pp. 43-69, (1996).

[10] Slavin, R. E., "Cooperative learning", NY: Longman, (1983).

[11] Slavin, R. E., "Cooperative learning: Theory, research, and practice", NJ: Prentice Hall. (1990).

[12] Tyan, N. N. & Hong, M. F., "Computer-Mediated Communication and Collaborative Learning in Higher Education", Journal of National Taipei Teachers College, Vol. 11, pp.1-22. (1998).

[13] Wang, C. H., "Cooperative learning", The Educator, Vol. 364, pp.34-38, (1997).

[14] Wang, W. C., "Cooperative learning in Mathematics", Friends of Elementary Education, Vol. 49, No. 4, pp.17-23, (1998).

A Dynamic WBI System supporting Individual Learning Styles

Jae-Mu Lee and Du-Gyu Kim
Department of Computer Education, Pusan National University of Education
263, KoJeDong, YounJeGu, PUSAN, 611-736 KOREA
Tel:+82-51-5007322
Fax:+82-51-5007174
E-mail: jmlee@ns.pusan-e.ac.kr

Being based on the hypertext structure, existing WBI provides various instruction paths. However, learners are provided with the same instruction content with little consideration of each learner's learning style. Therefore, WBI is lacking as a system that encourages individual learning, by failing to provide for different instruction methods for each learner. This prototype system can find the most effective approach to learning for each learner by analyzing a learner's achievement and learning history. It also provides instruction content based on the most effective instruction method for the learner taking into consideration learning style.

Keywords: **Web Based Instruction, Adaptive Learning, Individual Learning**

1 Introduction

The World Wide Web provides all learners with materials for instruction, and those materials have a hypertext structure similar to the way human beings perceive information, to effectively help learners understand them[3]. The Web enables us to communicate with anyone, anywhere, and at any time by a wide variety of materials irrespective of time and place[2].

While the Web has these advantages and educational effects, there are some problems. WBI does not consider an effective instruction program to present the materials for each individual. That is, all learners are provided with the same instruction content with little consideration of each learner's learning style. Therefore, it is worthwhile to develop an instruction program wherein is provided a more efficient instruction method for learners.

This study focuses on presenting the instruction content more individually, subject to the learners' process and achievement level of learning. An appropriate content is presented after analyzing each learner's individual needs. The aim is then to design and implement a system that can supply the most effective method for each learner after consideration of preferred learning styles, though the ultimate goal may be the same.

2 Related Works

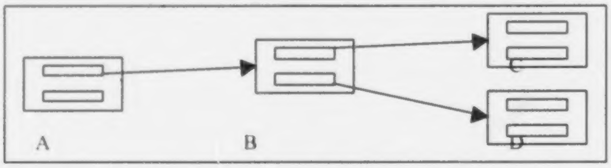
Norihito Toyota classifies a learner's study type into HLT (Horizontal Learning Type) and VLT (Vertical Learning Type). In HLT, a learner studies broadly, gaining wide knowledge. However, they lack a deeper understanding. On the other hand, in VLT, a learner studies more deeply, gaining some specific knowledge and understanding it logically; however, they lack that wider understanding gained only by studying across a broader base and viewing the whole from various angles of vision. They also cannot proceed independently, so long as something is not understandable. The learners of this type can increase their knowledge reliably, step by step, to recognize the whole scope. It has the other advantage of supplying the content for instruction after considering the learning style in each step[5].

Referring to an individualized instruction in Mathematics education, G. Lenchner proposed that all learners differ in the preference method to solve the questions. That is, each learner shows a different solution to the same question[6].

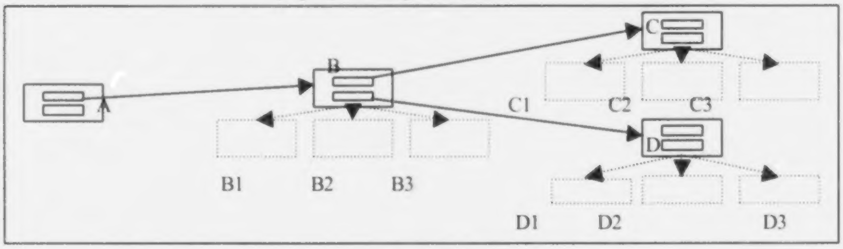
Paying attention to Norihito Toyota and G. Lenchner's proposal, this study focuses on providing learners with instruction content through effective methods, by analyzing the instruction process of learners of Mathematics at elementary school.

3 Design and Implementation of the System

As a system for this study, Windows NT Server 4.0 is set up as the Operating System, IIS 3.0(Microsoft) as the Web Server, and MS-SQL 7.0 as the Database. Interface with clients is made through the MS Explorer 4.0 or Netscape Communicator 4.0 (or higher version) Web browser.



[Fig 1] Existing WBI



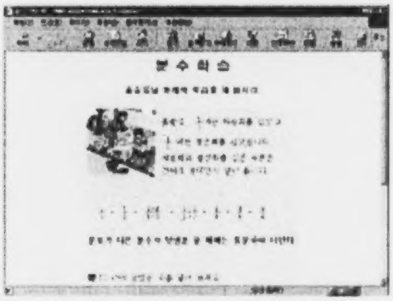
[Fig 2] Dynamic WBI System Considering Learning Style

Our system has a distinctive feature compared with the existing WBI system. As shown in [Fig 1], existing WBI presents paths of instruction for learners, nodes A, B, C, and D. But, this system finds the most effective one among B1, B2, and B3 to provide a learner with, instead of node B as shown in [Fig 2] Dynamic WBI System Considering Learning Style. (BI, B2, and B3 contain the same content but different method of instruction). Additionally, one out of C1, C2, and C3 is presented instead of node C. That is, while the existing WBI system has provided learners with learning paths A-B-C or A-B-D without considering learning styles, this system can present a wide variety of learning paths like A-B1-C1, A-B2-C2, A-B3-C3, A-B1-D1, A-B2-D2, A-B3-D3, etc. according to learning styles.

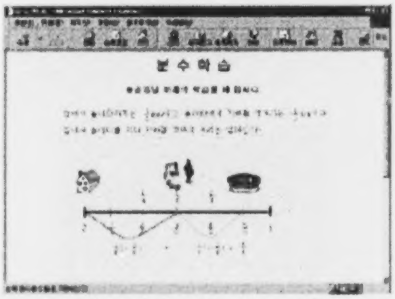
When a learner chooses the next step for learning after completing one learning step, results of the completed learning is stored in the Database. This stored data is analyzed in the Learning Style Analysis Module. Through this analysis, learners can be provided with the most effective instruction method from styles A, B, and C.

Instruction methods are classified into type A, B, and C in the whole process of learning. Type A is an instruction method using concrete materials, B is one using vertical lines, and C is one using explanatory sentences and numerical formulae.

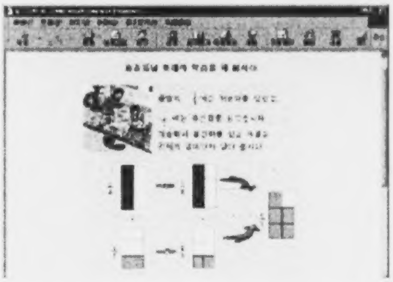
On the other hand, the analysis module analyzes the course that a learner has followed, and their level of achievement. And with a learner's understanding of the instruction content dependent in part on which type of instruction method is employed, a learner's achievement level is imposed on the variables of type A, B, and C respectively. Imposed scores are accumulated, and after a fixed instruction step, the most effective instruction content among the instruction method types A, B, and C (the content of which are the same) are presented according to accumulated scores.



[Fig 3]Addition of two fractions differing in denominators. (An Instruction Method expressed in explanatory sentences and numerical formulas)•



[Fig 4]Addition of two fractions differing in denominators (An Instruction Method expressed in vertical lines)•



[Fig 5] Addition of two fractions differing in denominators (An Instruction Method expressed in concrete materials)•

In other words, learners can be provided with the most effective content different from one another in accordance with which instruction method is most effective for them, although they choose the same level of instruction content through the analysis of their learning process. Therefore, learners can take a more advanced individualized instruction.

For instance, when instruction content named "Addition of two fractions differing in denominators" are chosen, the most effective instruction [Fig 5] among methods [Fig 3], [Fig 4] and [Fig 5] is presented as follows:

4 Conclusion

This thesis focuses on development of a system, which can find the most effective method with which to provide instruction to learners, by analyzing their learning process and results.

Expected effects in application of this system are as follows.

First, if this system is applied to Virtual Education, learners are no longer provided with the same instruction content regardless of personal level; they are instead offered an instructional content and approach that takes into consideration their learning style. Additionally, even if they are of the same content, individualized instruction is possible because the most effective instruction method considers the learner's cognitive processes.

Secondly, it is almost impossible to provide each student with a proper instruction method for him in class lessons under the existing educational system. However, this system can maximize the educational effect by presenting the individualized content in accordance with which instruction method is the most effective for each learner. A problem yet to be addressed is that of verification of the benefits to be gained and the overall educational effect of this system.

References

[1] Corning.M. (1997), "Working with Active Server Pages". Queco

[2] Ibrahim.B, Franklin.S.D (1995), "Advanced Educational Uses of the World Wide Web", Proceedings of the 3rd International Conference on the WWW

[3] Kim D.H (1998), "Making and Using Web Documents for Elementary Education", Korean Association of Information Education Proceedings of the 3th KAIE Summer Conference, pp.72-89

[4] Kim.S.S, Hwang.D.J , Jeong.C.G (1997), "A Multimedia Collaboration Home Study System" Proceeding of High Performance Computing ASIA'97 Conference and Exhibition sponsored by IEEE Computer Society, Seoul Korea, Apr, pp135-152

[5] Norihito.T(1997), "Fundamental Models on Individual-Type Learning Support System with Dynamic Strategy", The Institute of Electronics Information And Communication Engineers, ET 97-5, pp33-40

[6] Park S.T (1998), "Strategy of Instruction and Learning for Mathematics" , Kyomoonsa, pp116-124

[7] Tilton.E (1996), Composing Good HTML. http://www.cs.cmu.edu.~tilt/cgh

A European Learning Environment: Reflections on Teaching and Learning in a Multinational Virtual Learning Community

Brian Hudson*, Ahmed El-Gamal, Amal Gouda**, Eric Knutsen***, Merja Ruotsalainen****, Antti Peltonen****, Minna Pesonen**** and Tarja Tervola******
**Pädagogische Akademie des Bundes in Oberösterreich, Linz, Austria*
***Pedagogy and New Technologies Research Group, School of Education,*
Sheffield Hallam University, Sheffield S10 2BP, United Kingdom
B.G.Hudson@shu.ac.uk
a.e.gamal@shu.ac.uk
a.gouda@shu.ac.uk
****Hope Valley Community College, Hope Valley, Derbyshire S33 6SD,*
United Kingdom
knutsen@dircon.co.uk
*****Research Unit for Educational Technology, P.O.Box 2000*
90014 University of Oulu, Finland
Merja.ruotsalainen@oulu.fi
antti.peltonen@oulu.fi
mpesonen@oulu.fi
ttervola@ktk.oulu.fi

This paper outlines the background to the development of a European Masters programme in *Multimedia Education and Consultancy*. The development arises from an Advanced Curriculum Development (CDA) Project supported by the European Commission under the SOCRATES programme, which involves nine institutions in seven different European countries. The aims and outline of the Masters programme are described together with the pedagogical approach adopted. A key feature of the latter is a virtual learning environment that is underpinned by the use of the concept of "metaphor". This is intended to convey how the technical construction of the pedagogical functions communicates the background theories of the learning environment to the users. A pilot unit/module on *ICT in Open Learning Environments* is outlined together with some of the key features of the learning environment. This was trialled by a group of students based at locations in Finland, Austria, the Netherlands and the UK during the second semester of the academic year 1999-00. Evaluations are provided by a participating tutor, an observer and from two participating students. Finally some reflections are outlined which focus on the innovative aspects of this learning environment and of our experiences as teachers and learners in a multinational virtual learning community.

Keywords: **Collaborative Learning - Web-Based Learning - Networked Social Learning - Teaching and Learning Processes**

1 Introduction

This paper reports on experiences as teachers and learners in a multinational virtual learning community, which have resulted from our involvement in a pilot unit as part of the development of a European Masters course. The pilot unit is entitled *ICT in Open Learning Environments* and our involvement has taken place between February and May 2000.

2 Background to the development

The background to the development is the Advanced Curriculum Development (CDA) Project *TRIPLE M: Masters in MultiMedia Education and Consulting* that is supported by the European Commission under the SOCRATES programme (29268-IC-2-97-1-AT-ERASMUS-CDA-1) over the period 1998 to 2001. The *TRIPLE M* project is co-ordinated by Pädagogische Akademie des Bundes in Oberösterreich, Linz, Austria and involves a number of departments and research units with experience and expertise in teacher education and the use of Information and Communication Technology (ICT). The current participating institutions in the *TRIPLE M* project are:

- Pädagogische Akademie des Bundes in Oberösterreich, Linz, Austria (Co-ordinating institution)
- Charles University, Prague, Czech Republic
- Hogeschool Arnhem and Nijmegen, Netherlands
- Liverpool Hope University College, United Kingdom
- Pädagogische Akademie Vienna, Austria
- Sheffield Hallam University, United Kingdom
- Umeå University, Sweden
- University of Oulu, Finland
- University of Santiago de Compostela, Spain

A sub-group of the TRIPLE M Consortium has formed the *European Association for Multimedia Education and Consultancy™ (EAMEC™)* with the intention of offering a validated Masters programme in for *Multimedia Education and Consultancy* from September 2000. Initially this will be offered as a part-time route with a plan to run the programme on a full-time basis from September 2001.

3 Programme aims and outline

The academic aims of the programme have been developed in response to the needs of the 'Information Society' phenomenon related to the rapid development of high technology use in all sectors of society. The programme aims to meet the needs of teachers in schools and further and higher education especially. Specifically the programme seeks to develop the profile of the 'problem solver'/team co-ordinator at the interface of pedagogical, technological and organisational/cultural dimensions of development. In summary the programme aims to support the development of individuals who are able to:

- demonstrate and communicate knowledge and critical understanding of pedagogical issues as applied to the use of multimedia in new learning environments
- critically understand the social, organisational and cross-cultural phenomena related to new learning environments in trans-national and cross-cultural contexts
- appreciate and be responsive to the social and cultural impact of the Information Society in relation to values and working practices
- act as effective mediators and facilitators at the interface between the needs of users and providers
- co-ordinate the efforts of multi-disciplinary teams in terms of problem analysis, design and implementation issues
- be aware of the staff development needs of new users and appreciate the support structures and strategies for continuing development
- demonstrate a critical understanding of (educational) research and its role in a context of rapid change
- remain open to critiques of the Information Society with particular regard to the social and cultural implications

The programme is made up of six units/modules that together make up 90 European Credits (ECTS). These are as follows:

- Open Learning Environments (*OLE* - 10 ECTS)
- Digital Media Applications (*DMA* - 10 ECTS)
- Communication and Consultancy (*CC* - 10 ECTS)
- Research Methodolgies (*RM* - 10 ECTS)

- Project Studies (*PS* - 20 ECTS)
- Dissertation (*DS* - 30 ECTS)

The four more structured units (OLE, DMA, CC and RM) all follow a common pattern of:
- Telematic-based Studies (50%) e.g. Web-based work and discussions, multi-point videoconferencing sessions, and
- Local and Independent Studies (50%) in national groups e.g. day workshops and tutorials plus independent study.

4 Pedagogical approach

The pedagogical approach involves Telematic-based Studies in Web-based work, discussions and multi-point videoconferencing sessions in multinational learning communities. It is seen as crucial that these studies are supported by Local Studies - in national groups e.g. day workshops, practical activity, project work, research activity and tutorials and Independent Studies including literature reviews, independent project work, research activity, writing etc.

The use of ICT as a medium for learning and communication is fundamental to the underpinning philosophy of the programme and is an integrated and all pervasive aspect of the pedagogical approach, both in terms of learning about it and as an essential part of the learning process. Students need to use the Internet as an essential part of the learning and communication process.

The platform for the net-based learning environment is *LC Profiler – Learning Community Profiler*. This is the product of *LCProf Oy*, which is a Learning Service Provider (LSP) and a 'spin-off' company of the University of Oulu. The services are based on the methodology and system developed at the University of Oulu in a range of domestic and EU R&D and education projects during the last 5 years (e.g. Telematics projects T3: Telematics for Teacher Training, SCHEMA: Social Cohesion through Higher Education in Marginal Areas). The implementation of the system is based on the principle of creating a distributed community of learners and supporting the tutors to enable them to create their own learning communities. This means that the tutors also belong to a unique learning community of their own, which aims to support ongoing professional development.

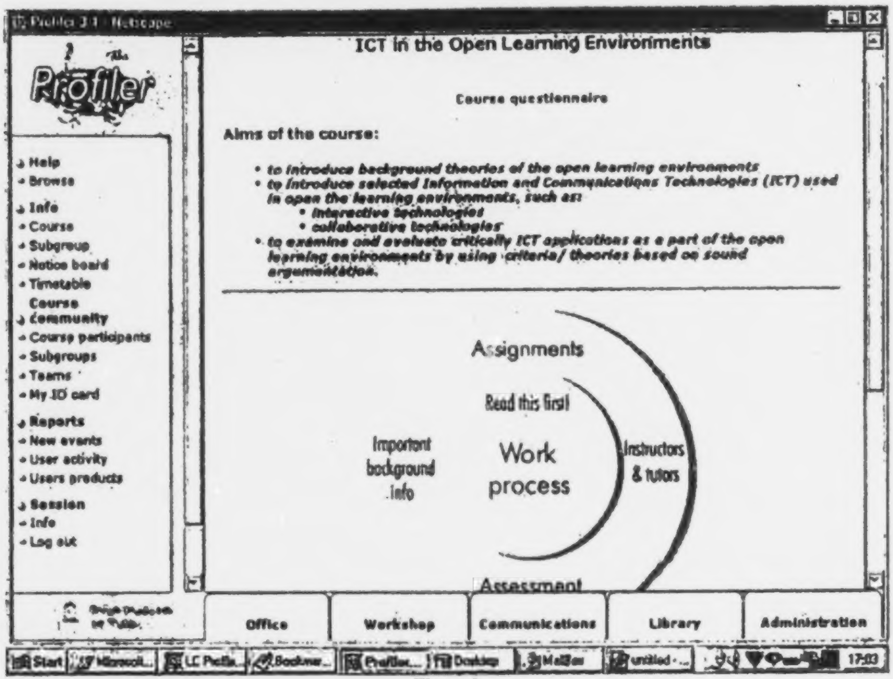
5 The role of metaphor

The concept of metaphor plays a fundamental part in the underlying design of the *LC Profiler* environment and also in signifying key functions to the user. In their paper Pulkinnen and Peltonen [1] use the concept of "metaphor" to "explain how the technical construction of the pedagogical functions communicates the background theories of the learning environment to the users". This paper is also one of the Core Readings for all students on the OLE unit/module. Their analysis combines ideas about knowledge, the structure of knowledge and learning with social aspects to do with the organisation of learning such as practical arrangements connected with "time, place and repetitive rituals". Their overall metaphor which captures the nature of the *LC Profiler* environment is of "a place of studying (virtual space) created with the help of ICT". The three "cornerstones" of their analysis of the learning environment are the individual whether as teacher or learner, the technology and the culture as fully outlined in Pulkkinen and Ruotsalainen [2]. They describe these as providing the "cross-disciplinary basis for the elements that are necessary for learning" and identify these elements as pedagogical functions, appropriate technologies, and the social organisation of education

6 The pilot unit/module

As part of the curriculum development process, two units have been piloted during the period from February to May 2000. These are *ICT in Open Learning Environments* (February to May*)* and *Digital Media Applications* (March to May). The former is based on an existing unit/module at the University of Oulu and forms the model for the development of the Masters programme as a whole. The full unit/module is worth 10 ECTS M Level credits for which 5 ECTS is available for successful completion of the telematics-based component. This was trialled as part of the TRIPLE M project with a group of about 25 Finnish, 9 Austrian, 4 Dutch and 2 UK students

The course outline is seen as one of the most important navigation tools, referred to as an "orientation metaphor". The introductory screen is shown below in Fig 1.



ICT in the Open Learning Environments

Course questionnaire

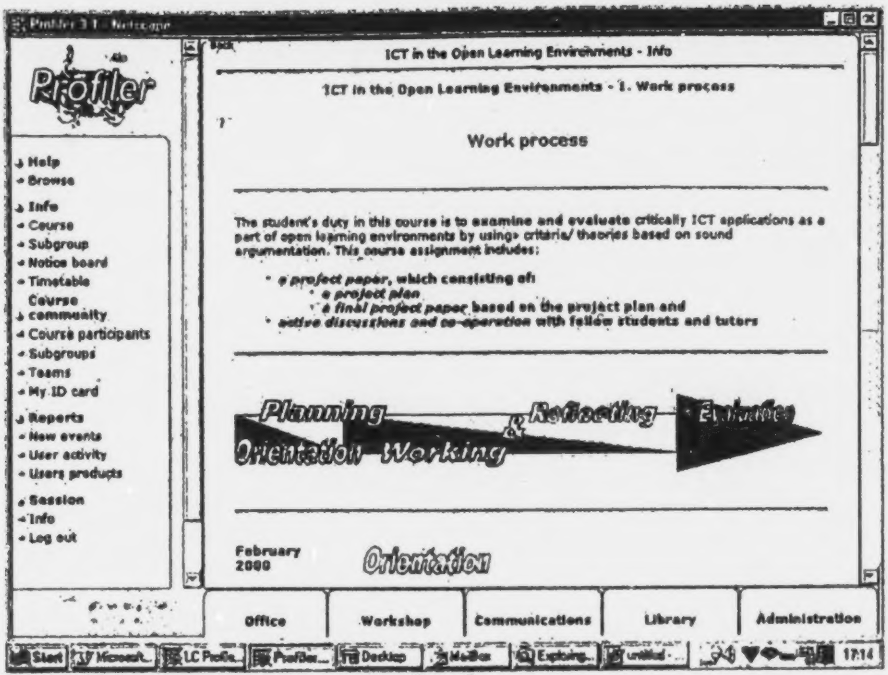
Aims of the course:

- *to introduce background theories of the open learning environments*
- *to introduce selected Information and Communications Technologies (ICT) used in open the learning environments, such as:*
  - *interactive technologies*
  - *collaborative technologies*
- *to examine and evaluate critically ICT applications as a part of the open learning environments by using criteria/ theories based on sound argumentation.*

Profiler 3.1 - Netscape
The Profiler
Help
Browse
Info
Course
Subgroup
Notice board
Timetable
Course community
Course participants
Subgroups
Teams
My ID card
Reports
New events
User activity
Users products
Session
Info
Log out
Assignments
Read this first!
Important background info
Work process
Instructors & tutors
Assessment
Office
Workshop
Communications
Library
Administration
Start
17:03

Figure 1

This screen includes a statement of the aims of the course and also conveys some of the metaphors that underpin the design of the system. (NB The use of the term "course" here is equivalent to the terms "unit/module" used previously and is a reflection of the diversity of the use of these descriptors across and within different systems) The most apparent metaphors are those which are to do with orientation to place or virtual working place. The Project Office, Workshop, Communications Centre, Library and Administration Centre refer to "working" and not to the technology and tools being used e.g. e-mail, chat, documents etc. This aspect is seen to be a particularly important issue in relation to signifying metaphors to users that refer to pedagogical practices. The metaphor of "project" is used to convey "the basic essence of learning" and the course flow orientates the user to time. This includes phases on the work process e.g. orientation, planning etc and also milestones, which are outlined in part in Figure 2.



Profiler 3.1 - Netscape
Profiler
Help
Browse
Info
Course
Subgroup
Notice board
Timetable
Course community
Course participants
Subgroups
Teams
My ID card
Reports
New events
User activity
Users products
Session
Info
Log out
Office
Workshop
Communications
Library
Administration
Start
Microsoft...
LC Profile...
Profiler...
Desktop
MailBox
Exploring...
untitled
17:14

ICT in the Open Learning Environments - Info

ICT in the Open Learning Environments - 1. Work process

Work process

The student's duty in this course is to examine and evaluate critically ICT applications as a part of open learning environments by using» criteria/ theories based on sound argumentation. This course assignment includes;

- *a project paper*, which consisting of:
  - *a project plan*
  - *a final project paper* based on the project plan and
- *active discussions and co-operation* with fellow students and tutors

Planning
Orientation
Working
&
Reflecting
Evaluation

February 2000

Orientation

Figure 2

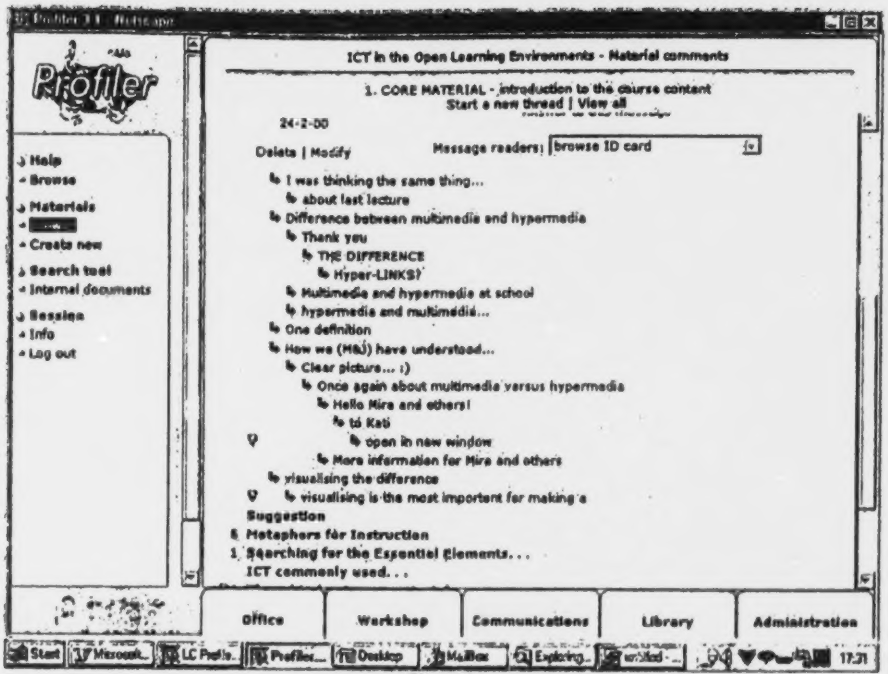
7 Experiences as teachers and learners

This section includes accounts and evaluations from a participating tutor (Brian Hudson), an observer (Ahmed El-Gamal) and from two participating students (Eric Knutsen and Amal Gouda).

As a particpating tutor I was immediately struck by the very clear sense of purpose that the course outline engendered with a very clear sense of the different phases, milestones and overall timescale. The active participation in discussions was not an option but a necessary requirement with comments being expected within fixed timescales and core readings, project plans of peers etc. As a result the level of communication on the course was very high - an analogy might be made with lighting a wood and coal fire - a little slow at the start but then bursting into flames from all sides!

Another key observation was of the role of the two main moderating tutors. Both could be characterised as being "on task" throughout the course of the unit/module. In general their responses to questions were very swift and they dealt with technical, pedagogical and social issues. The two tutors also interacted with each other in a very effective way by following up on each others comments, questions and prompts - so engendering a relaxed yet lively ambience around the discussions.

An example of the extent of the student discussions can be gleaned from the screen in Figure 3 below:



ICT in the Open Learning Environments - Material comments

1. CORE MATERIAL - introduction to the course content
Start a new thread | View all

24-2-00

Delete | Modify

Message readers: browse ID card

- I was thinking the same thing...
  - about last lecture
- Difference between multimedia and hypermedia
  - Thank you
    - THE DIFFERENCE
      - Hyper-LINKS?
  - Multimedia and hypermedia at school
  - hypermedia and multimedia...
- One definition
- How we (M&J) have understood...
  - Clear picture... :)
    - Once again about multimedia versus hypermedia
      - Hello Mira and others!
        - to Kati
          - open in new window
      - More information for Mira and others
- visualising the difference
  - visualising is the most important for making a

Suggestion
5 Metaphors for Instruction
1 Searching for the Essential Elements...
ICT commonly used...

Figure 3

The particular thread started outlined above was started by student H on 24-02-00 with the comment:

Could some of you tell me what is the difference between multi- and hypermedia? Is there any difference, do they mean the same thing? The difference between these "words" was explained in the first core text but I just couldn't find the basic idea which might help to separate them.

These questions resulted in a rich, intense and well-informed discussion with around twenty contributions over a ten-day period, which seemed to conclude in an agreed consensus. Overall discussions were by no means restricted to technical matters but this particular thread was notable for its richness and intensity. A notable feature of this environment is the very clear way in which the threads are laid out and also the way in which the links are revealed when a thread such as the one above is opened.

Ahmed El-Gamal had the role of being a Local Tutor and was given access to *LC Profiler* as an observer. He is a staff member of Menofia University in Egypt on a PhD scholarship supported by the Egyptian Ministry of Education and Culture. He has chosen to cluster his comments around characteristics that he noticed about the learning environment in overall terms. This is a summary of his comments on these charactersitics:

Organization: The whole unit is well organized e.g. timetable, assignments, activities..etc. If there is any misunderstanding the student can post a question to the others.

Adaptability:Most of students adapted easily with this learning environment. Sometimes they have some technical problems e.g. the speed and the difficulty in using some tools, but they soon found assistace from the tutors and their peers.
Flexibility:It is a very flexible learning environment - students worked at different times in different countries, yet they have the opportunity to discuss the same topics.
Some students from different countries were able to create teams to conduct the same project.

Collaboration: Students collaborated with each other in solving some technical problems, clarifying some aspects in the references, developing teams and developing their project plans.

BEST COPY AVAILABLE

Conversation and discussion: Students were discussing different issues that were relevant to the course. All the participants have the opportunity to contribute to the discussion. They wouldn't end the discussion until they reached an agreement about the topic e.g. the discussion about the difference between Multimedia and Hypermedia was about 20 comments.

Social interactivity: Most of students have some social interactivity, by talking to the other students in the on-line café and by posting messages. Some friendships have been developed during the course.

Amal Gouda has studied to Diploma level in Educational Technology at Cairo University and is continuing her Masters studies at this time. She has chosen to group her evaluation around features of the studying process:

The studying process in OLE could be defined as an integrated process, which integrates the different resources and the different parts of the OLE to achieve the desired goals. The studying process in OLE is accomplished through the following parts:

Office: Every student can manage almost all his/her study through using the office and all the information about the course and other students are available on the office, in addition to the timetable and the framework of the course.

Workshop: Every student has developed his/her project plan and he/she has published it to the other course participants. This gave his/her opportunity to have the other students comments on it.

Communications: It gave the international students the opportunity to freely discuss different topics related to the course. It also allows them to discuss their project plans and the other students' project plans. Moreover, there are different categories for discussion e.g. questions and urgent message, general discussion about the study process..etc. In online café, the students can have a social chat with their peers.

Library: It has most of references that are related to the course, also it has a hyperlinks to enable students from browsing more materials. It was advised to write comments on these materials, in order to encourage the students to read them carefully.

Local studies: Every student met with his/her tutor many times to discuss the different topics and activities that seem to be unclear and to guide him/her through the course. The most important feature in the studying process in OLE is that it gave the opportunity to study and discuss different topics at any time during the day.

Eric Knutsen works in a secondary school and is in his first year of teaching as a teacher of ICT. He has chosen to respond to the aims of the course and to evaluate the extent to which these were met for him as a student:

- to introduce background theories of the open learning environments

This was done in a straightforward manner utilising the OLE of LC Profiler. It was useable as one would use a library in the traditional environment of a physical learning environment. The added value here was the amount of material referenced via the web. Using the expertise of the instructors on the course, I was able to make use of the varied written material and discuss other students' and my own opinions on the content. Being done in an asynchronous way, there was no need to be present physically or virtually for such discussion. Yet, I had the advantage of dozens of other opinions from which to draw my own conclusions. This took my learning beyond that previously possible via ...traditional learning ...

- to introduce selected (ICT) Information and Communications Technologies used in open learning environments, such as interactive technologies and collaborative technologies

One aspect of having been introduced to the background theory in the way it was done is the ability to review tens of project proposals and final project papers in light of the theory examined. This made the theoretical come to life, especially when undertaking my own individual work. This meant looking critically at the variety of components comprised with-in the environment being examined ...What made this a more lively introduction to the ICT was the regular use of LC Profiler and the success of the discussions taking place.

- to examine and evaluate critically ICT applications as a part of the open learning environments

by using criteria/ theories based on sound argumentation

BEST COPY AVAILABLE

Given the foundation above ... it was straightforward to see the relevance of the theory when examining the OLE at hand. Especially of interest was the use made of LC Profiler as an OLE by all members of the course and the social interaction made possible by all areas of LC Profiler, not isolated to the on-line cafe. This even fed the theoretical side to my thoughts about my assignment.

8 Conclusions

The experience of participating in this pilot unit has provided a real example of the transformative potential of the use of ICT. This is in spite of several years experience of using the *First Class* conferencing software which seems quite limited by comparison with *LC Profiler*. In McConnell's [3] terms *First Class* can be seen to be simply an example of "unstructured groupware" or an "electronic space". Some experiences result in real and lasting changes - for myself this experience has transformed my own pedagogical thinking and practice. Whilst being a vital component, the learning environment of itself is not the main ingredient for experiencing this transformation, although many people at this time are looking for the "quick fix" and simple solutions. However it has been the experience as a participant in a community of practice (Hudson [4]; Lave, [5] and Lave and Wenger, [6]) that has been fundamental. This process takes time and is about changes within (the person) and developing new ways of relating to other people. In general terms such high levels of on-line communication also necessitate the need to develop a more relaxed attitude towards committing ideas into print, for seeing such comments as transient and not permanent and being accepting of the need for "repairs" to communication as one would in more traditional forms of communication.

References

[1] Pulkkinen, J. and Peltonen, A. (1998) Searching for the essential elements of Web based learning environments, 3^{rd} *International Open Learning Conference*, 2-4 December 1998, Brisbane, Queensland, Australia.

[2] Pulkkinen, J. and Ruotsalainen, M. (1998) Evaluation study of a telematic course for technology teachers (T3 Project). Paper to the *Teleteaching' 98 Conference of the* 15^{th} *IFIP World Computer Congress*, 31 August - 4 September 1998, Vienna and Budapest.

[3] McConnell, D.: 1994, *Implementing Computer Supported Co-operative Learning*, Kogan Page, p37.

[4] Hudson, B. (1999) A social perspective on teaching and learning in the context of Computer Mediated Communication in teacher education, *Journal of Information Technology in Teacher Education*, 8, 2 (In press)

[5] Lave, J.:1996, Teaching, as learning, in practice, *Mind, Culture and Activity*, 3, 3, 149-164.

[6] Lave, J. and Wenger, E.: 1991, *Situated Learning: Legitimate Peripheral Participation*, Cambridge University Press.

A Framework for Internet-Based Distributed Learning

Andreas Braun* and Andreas G. Harrer**
**Andersen Consulting, Maximilianstr. 35, D-80539 München,* andreas.braun@ac.com
***Technische Universität München, Orleanstr. 34, D-81667 München,* harrer@in.tum.de

Communication technology as well as the communication infrastructure are both changing rapidly. As a consequence, systems that support web-based learning need to be adapted due to changes in technology. This paper describes a model for web-based learning with intelligent tutoring systems (ITS) that allows separation of the concrete communication from the ITSs' implementation. The resulting framework provides a technical solution to distribute any ITS over a network. The ITS SYPROS is used to illustrate how a classical ITS can be extended to a web-based tutoring system with a maximum of code-reuse. The framework may be used freely with any ITS. To accommodate the needs of various ITSs, our model supports several architectures for distributed adaptive tutoring, including the three different models described in [3]: Master-Slave, Communicating Peers and Centralized Architectures. Our main goals are: • •Make the ITS usable for a wide range of users by supporting any web browser on any operating system.• •Offer a simple, extendable and platform independent framework to ease web-based tutoring.• • Provide a solution without royalties.• •Separate the communication technology from the client and server implementation.• •Enable method invocation and parameter passing semantics over the HTTP protocol to virtually support any web browser and users behind firewalls. • •Offer an simple user accounting and user communication functionality.• •Provide a wrapper to connect to an existing ITS. The Java source code is freely available: http://www.in.tum.de/~herzog/sypros.

Keywords: **Web-Based Learning, System Design and Development, Intelligent Tutoring Systems**

1 Introduction

Classical intelligent tutoring systems (ITS) are often platform dependant and not distributed. Modern, distributed intelligent tutoring systems (DITS) provide a more attractive solution with respect to usability and platform independence. Therefore, a modern distributed infrastructure like the internet with communication techniques like CORBA or RMI is suitable. A stable, safe and extendable basis for communication and cooperative work is needed. However, technology in this area is rapidly changing on the one hand. On the other hand communication technologies like CORBA or RMI are (still) not usable with every client, browser or platform and still have several drawbacks which prevent their usability at least for some users: Macintosh users and users with old browsers or behind firewalls/proxies who also want to use secure socket factories, only to name some.

This paper discribes a model and the resulting framework to overcome such problems. We propose to address these problems by providing an API with the semantics of object oriented remote method calls over HTTP and Servlets. Further functionality that is most likely in common for any DITS (such as user accounting and identification, security and administrative functionality) is implemented and encapsulated for ease of use.

In the current version, SYPROS is an ITS in the domain of the synchronization of parallel processes with semaphores [4], a domain of programming problems.

All the typical modules of an ITS [15] like the expert module with different types of cooperating domain experts [13], the instructional module with different tutoring strategies, the student model with cognitive and motivational traits [12], and the interface module with several support facilities, are fully implemented in SYPROS.

The current version system is a classical ITS for single-user mode and is written in C for UNIX systems. The user interface is based on the X Windows system and therefore the ITS is platform dependent. There is no direct support for multiple clients and no accounting, access control or WWW support as it would be needed for a web-based group learning system, which is our ultimate goal [11]. In the current implementation the user interface is divided at function level from the 'intelligence' and database functionality, but is linked to one single executable. The proposed model will provide an application interface (API) for the client and server side. The API will encapsulate various ways of communication over a network using an abstract factory pattern [2,10]. Concrete implementations for Java RMI and servlets are provided. This model is designed to be easily extendable by other means of network transportation (e.g., CORBA or even Sockets). It will include conceptional security at an eligible level. Further, various ways of interfacing to an existing ITS on the server side are given (Java native calls to C/C++ and the connectivity to shell scripts). This factory can also be easily extended. Figure 1 shows the distribution of SYPROS. The servlet proxy Server enables connection for old webbrowsers, running not necessarily on the same machine as the `SyprosServer` implementation. Two clients are connected: "**Old Webbrowser**" connects using the servlet proxy, "**New Webbrowser**" can either use servlet communication or RMI[17]/ CORBA[22] (or anything else).

This work covers two more aspects: a security discussion for the provided model with a special focus on security issues for an ITS and a usability discussion for various platforms and webbrowsers.

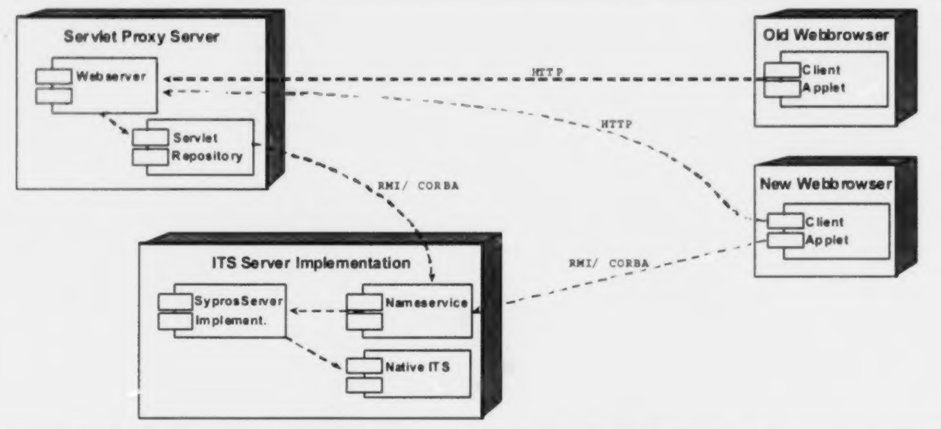


Figure 1. Distribution of client, server and servlet proxy in SYPROS (UML[19]).

Figure 2 shows the different layers for communication and levels of abstraction for a client initiated request. The dotted line between the implementation (application) level and the abstraction denotes that both the client and server implementation are separated from the underlying concrete communication. This model provides transparency in terms of process transparency. (That is, the machine on which the function or method is executed isn't known to the client's application level.) This can be compared to remote procedure calls (RPC) where the client stub and the server skeleton provide a similar transparency. In addition to that, our framework separates the concrete communication (the lowest layer in figure 2) from the application layer using the abstract communication layer. This provides transparency regarding the concrete communication technology used and therefore unburdens the application programmer from changing the application to support new technologies.

For some concrete communication implementations our framework supports language transparency as far as the client's implementation language may differ from the server's (e.g., for CORBA or Servlets).

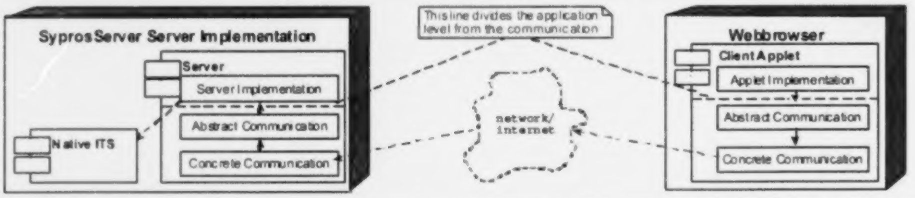

SyprosServer Server Implementation
Server
Server Implementation
Abstract Communication
Concrete Communication
Native ITS
This line divides the application level from the communication
network/ internet
Webbrowser
Client Applet
Applet Implementation
Abstract Communication
Concrete Communication

Figure 2. Levels of abstraction and layers for a request initiated by the client (UML deployment diagram).

2 Requirements

All base functionality for a distributed system is implemented. Remote method invocations are implemented independently from the Java RMI package over a `ComObject` which is JDK 1.1[9] compliant. User accounting, login procedures and access control as well as connection state information is supported directly in the framework.

A wrapper is provided to connect to an existing ITS over Java Native Interface (JNI[14]) or shell script invocation.

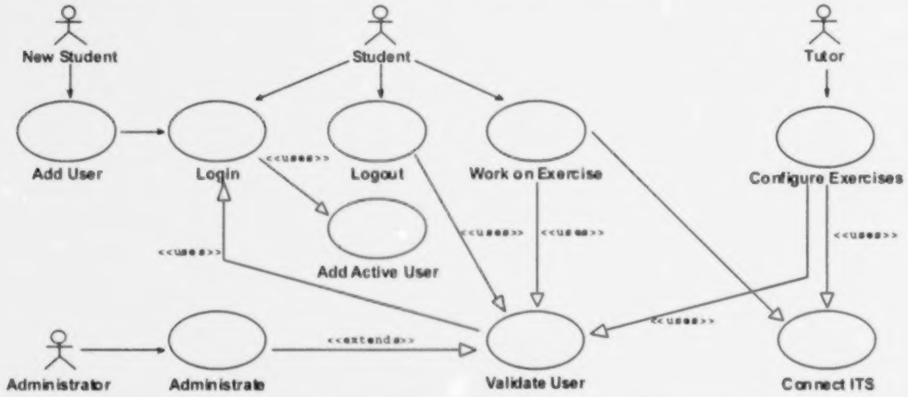

New Student
Student
Tutor
Add User
Login
Logout
Work on Exercise
Configure Exercises
<<uses>>
Add Active User
<<uses>>
<<uses>>
<<uses>>
<<uses>>
<<uses>>
<<extends>>
Administrator
Administrate
Validate User
Connect ITS

Figure 3. Some interactions among actors and use cases in SYPROS (UML use case diagram).

The use case diagram in figure 3 shows some of the use cases for SYPROS. Four types of human actors are shown in their interaction with the use cases. "**Student**" denotes an actor who is already known to the system. Therefore, "**Student**" logs into the server by passing the "**Login**" use case. "**Login**" performs authentification for which it `<<uses>>` the "**Validate User**" use case, which has knowledge of all valid user entries and so on. After accepting the user's login request some state information for that connection will be stored "**Add Active User**" and a `UserTicket` object is returned to allow stateful and secure client interaction. (`UserTicket` might be encrypted.)

"**New Student**" is an actor who is not known to the system. (Guests are handled identically.) Therefore, she can create a new user database entry herself ("**Add User**"). Later, the gathered information will be used to log into the system as described before.

An active user ("**Student**") might also use other services on the ITS server side. For example, the "**Work on Exercise**" use case first validates the call against the active users database and then uses "**Connect ITS**" (which interfaces the ITS using the wrapper) to work with the tutoring system.

"**Tutor**" is a human actor who might use the "**Configure Exercise**" use case to set up some exercises or check the student's results. The differing permissions (compared to a student) are handled by the "**Validate User**" use case.

An "**Administrator**" user will not use the client interface to connect to the server in this model. The administrator configures the databases and configuration files. Therefore, "**Administrate**" extends "**Validate User**".

Resulting from the requirements given before our model and the framework should further satisfy the following nonfunctional requirements, pseudo requirements and design goals: The server-side installation should be simple and conceptionally platform independent. It should not be addicted to any specific web server and should work with freely available products such as Apache.

The framework is designed to be fully platform independent using the Java programming language. However, some platform dependencies exist from possible webbrowser incompatibilities and the existing ITS. In order to support old webbrowsers or users behind a firewall or proxy, a servlet repository which acts as a proxy and a servlet based client communication is provided. The communication implementation may be switched online in the client implementation[1].

The SYPROS system can be used by four groups of people: students, guests (users who are not known to the system by now), tutors and administrators (tutors who fulfill administrative functions). Therefore, the framework supports users at different level of permissions (similar to e.g., UNIX or WindowsNT).

The client applet should be small so that it is suitable even for slow modem connections. The classes needed for communication on the client side are less than 20 KB in size (without JCE security). Once the Applet is loaded, the response time of the user interface is short, as it is running locally on the client side.

The response time resulting from the security key generation and secret key exchange (Diffie-Hellman for example) of the Java Cryptography Extension (JCE) is rather long especially for strong keys and due to JCE's implementation in Java (see discussion in section 4).

Performance of the network communication depends on the underlying infrastructure. With most browsers, servlets will have a more overhead than CORBA or RMI.

The communication framework aims to support three possible client-server binding: Static (the server name is stored in the client application), semi-static (the client locates the server once, e.g., at login time) and dynamic (the client looks up the server each time it needs to connect). Client server binding uses name resolution to find a suitable ITS server in the network. The toolkit uses a server string such as "***//{hostname|ip-address}/{service-name}***", just like RMI for either underlying communication infrastructure. At client implementation level, the programmer may decide whether to use static, semi-static or dynamic binding.

Together with the way of client-server binding, stateless and stateful client server connections using tickets are possible. User tickets are invented as "high-level" stateful client-server connection for two reasons: first, the underlying ITS needs to know about the caller; tickets provide an easy way to identify the caller during a learning session. Second, encrypted ticket objects can be used to prevent attacks by intercept and replaying messages (see section 4).

Calling a remote function is somewhat dangerous if the programming language used supports *call-by-reference*[2]. For Java, *call-by-reference* is replaced by a *call-by-copy/restore* semantics. (See Java `RemoteObject` for RMI). A *call-by-copy/restore* semantics can be simulated for servlets using the `EventListener` model. In that case, the servlet proxy uses a `RemoteObject` for the server communication if the communication between the servlet proxy and the server is based on RMI and returns the object to the client using the event model. This may also be encapsulated in the framework.

In case of middleware communication such as CORBA/ RMI the *call-by-copy/restore* semantics can directly rely on the appropriate native semantics. The framework supports synchronous method invocations. Asynchronous calls can be realized using *call-by-copy/ restore*.

---

[1] This feature should be omitted for maximum compatibility with old browsers and Java engines (JDK level 1.1).

[2] Function calls that use *call-by-reference* parameter passing deliver a pointer to the value or data the parameter stores. In a distributed system with different address spaces this triggers side-effects[20].

Java's `try-catch`-statements are used for error handling. Therefore, the framework's error semantics is *at-most-once* by default. At application level, return values might be used to signal unexpected behavior. The SYPROS `login()`-Method for example returns `null` for the `UserTicket` if the server can't accept the login request. Although there are several possible reasons for that (e.g., unknown user, wrong password) their origin is not a communication error.

The resulting framework is described using UML notation for scenarios, use cases and object models[2,19]. The API description is given in standard Java notation[9]. The use of our framework is illustrated by the SYPROS sample.

3 A Model for the Communication Framework

Figure 4 shows the UML diagram for the SYPROS server implementation using the communication framework. The diagram shows two possible extensions for `SyprosServer`: `ComCORBA` and `ComRMI`. In the realworld implementation the programmer has to decide either to use CORBA *or* RMI, as Java does not allow multiple class inheritance.

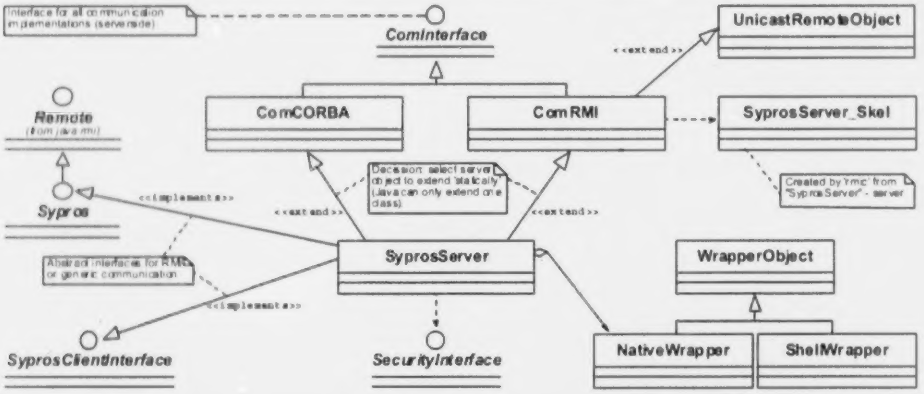

Interface for all communication implementations (serverside)
ComInterface
UnicastRemoteObject
<<extend>>
Remote
(from java.rmi)
ComCORBA
ComRMI
SyprosServer_Skel
Decision: select server object to extend 'statically' (Java can only extend one class)
Created by 'rmic' from "SyprosServer" - server
<<implements>>
<<extend>>
<<extend>>
Sypros
SyprosServer
WrapperObject
Abstract interfaces for RMI or generic communication
<<implements>>
SyprosClientInterface
SecurityInterface
NativeWrapper
ShellWrapper

Figure 4. SYPROS server implementation. Class attributes and methods are omitted. (UML class diagram)

Therefore, there are some specialties in the server implementation: depending on the selected communication technology, the programmer has to change the head of the class definition to extend the right `ComInterface`. Further, the server has to implement the `Sypros` interface which defines the exported functions (for the RMI case). `SyprosClientInterface` contains the same definitions like `Sypros` but doesn't depend on the Java RMI classes. This ensures usability for old webbrowsers (with old Java virtual machines, VM) or clients that don't support RMI for other reasons (Macintosh).

```
import sypros.util.*;
import sypros.com.util.*;
import sypros.com.server.ComRMI;

public class SyprosServer extends} ComRMI implements Sypros {
  public  SyprosServer(String hostName, String servName) throws RemoteException
{
    super(serverHost, servName);  // create bindings
  }
  public static void main(String args[]) {
    setSecurity();                 // setup default security
  }
}
```

Figure 5. Client applet implementation for the SYPROS sample.

Figure 5 shows the class definition for the SYPROS server implementation using RMI. The underlined statements would have to be changed for a different type of communication technology.

The client implementation allows dynamic switching of the communication technology. Figure 6 shows the UML class diagram for the SYPROS client Applet. As the client communication model uses an abstract factory pattern [2,19] to create the appropriate concrete communication, the client might be a Java Applet or a Java standalone application. (The server could also be connected using the servlet URLs from HTML or other languages.)

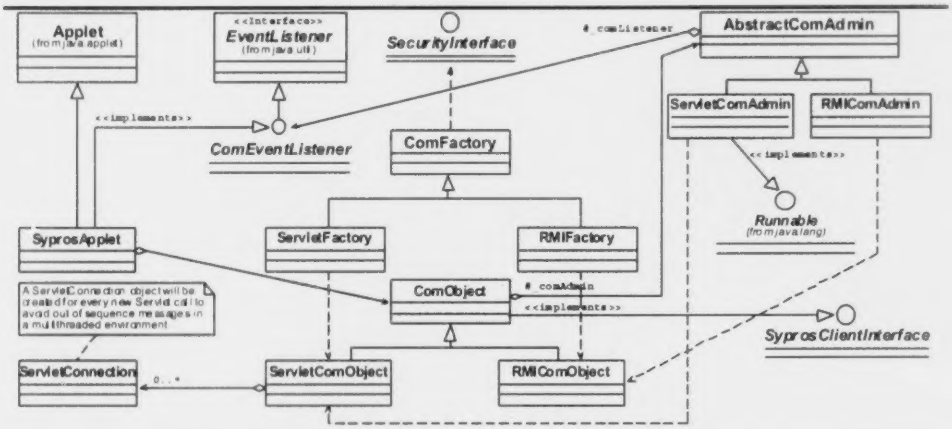

Applet
(from java.applet)
<<Interface>>
EventListener
(from java.util)
SecurityInterface
# _comListener
AbstractComAdmin
<<implements>>
ComEventListener
ComFactory
ServletComAdmin
RMIComAdmin
<<implements>>
Runnable
(from java.lang)
SyprosApplet
ServletFactory
RMIFactory
A ServletConnection object will be created for every new Servlet call to avoid out of sequence messages in a multithreaded environment
ComObject
# _comAdmin
<<implements>>
SyprosClientInterface
ServletConnection
0..*
ServletComObject
RMIComObject

Figure 6. Client applet implementation for the SYPROS sample (UML class diagram).

The classes in the client model can be seen in three categories. First of all, SyprosApplet is the implementation for the SYPROS client interface. (Plus `Applet`, the parent.) As described before, the implementation needs not to be changed for changing communication technologies.

Then the communication classes themselves: `ComFactory`, `ComObject` and their concrete implementations provide the application interface for the implementation. `ServletConnection` is a helper that provides a per-servlet connection for persistent calls in a multithreaded application.

The `AbstractComAdmin` and its concrete implementations for servlets and RMI currently realize notification for server to client messages using the `EventListener` model and can be used for *call-by-copy/restore* type parameter passing.

4 Conceptual Security

Any internet-based application requires a special focus on security issues. The history of designing secure systems, however, teaches the inadequacy of enhancing existing systems with additional security functionality [8]. To integrate the security functionality for secure web-based tutoring, we included security policies in the framework with a top-down approach. We start by specifying the security requirements as part of the security policy:

Authentification:	All subjects and objects of the system have to be authentificated.
Total access control:	Every access to protected units has to be supervised.
Non repudiation:	Every action performed by a subject can be assigned to it's originator.
Communication privacy:	Dataflow over unsafe networks has to be adequately encrypted.
Availability:	Denial-of-Service attacks should be identified.

To meet the authentification, total access control and no-denial requirements, the framework offers integrated functionality that can be adapted or extended to your application needs. Communication privacy is provided using encrypted transmission (encrypted object serialization) based on the Java Cryptography Extension (JCE). JCE offers secret key agreement protocols (e.g., Diffie-Hellman) and encryption (e.g., Blowfish) with variable key lengths.

Ensuring the availability of a web-based service against denial-of-service attacks is maybe the hardest task. The Servlet-Proxy allows load-balancing, where the typical communication load of an ITS application (little amounts of data, long periods of thinking, infrequent transmissions) can be used to identify attacks.

5 Conclusions and Outlook

Our framework offers an easy and extendable basis for web-based distributed tutoring. The communication technology, security and ITS-integration can be easily adapted to the specific needs of an existing ITS as well as to changing communication or security technologies without rewriting the implementation for the ITS clients or server.

User accounting and access rights deliver the basis to support groups of students. However, support for cooperative work should be included in the ITS itself, like for example in SYPROS.

6 List of tested Browsers

✓: tested ok. no: tested, but failed. –: browser/ OS combination not available for testing.

Webbrowser	Version	Win98/NT		Linux		Solaris/x86		Solaris/Sparc		Macintosh	
		Servl.	RMI	Servl.	RMI	Servl.	RMI	Servl.	RMI	Servl.	RMI
Netscape	4.04	✓	✓	–	–	✓	–	–	–	✓	no
Netscape	4.05	✓	✓	✓	✓	–	–	✓	✓	–	no
Netscape	4.7	✓	✓	✓	✓	✓	✓	–	–	–	no
Netscape	4.72	✓	✓	–	–	–	–	–	–	✓	no
I-Explorer	4.0	✓	no	–	–	–	–	–	–	–	–
I-Explorer	5.0[3]	✓	✓	–	–	–	–	–	–	–	–
Java Plugin	1.2	✓	✓	✓	✓	✓	✓	✓	✓	–	–

References

[1] Braun, A., "A Client-Server Model for an Intelligent Tutoring System" (transl.), Technische Universität München, Diploma Thesis, May 2000.

[2] Brügge, B., Dutoit, A.H., "Object-Oriented Software Engineering: Conquering Complex and Changing Systems", Prentice Hall, Upper Saddle River, NJ, Oct. 1999.

[3] Brusilovsky, P., Ritter, S., Schwarz, E., "Distributed intelligent tutoring on the Web", in: Proceedings of the 8th. World Conference of the AIED Society, Kobe, Japan, Aug. 1997.

[4] Dijkstra, E.-W., "Cooperating sequential processes", in: F. Genuys (editor), Programming Languages, Academic Press, New York, Oct. 1968.

[6] Duncan Davidson, J., "Java™Servlet Specification v.2.2", Sun Microsystems Inc., Oct. 1999.

[7] Eckert, C., "Matching Security Policies to Application Needs", Proceedings of the IFIP TC11 11th Internation Conference on Information Security, Cape-Town, South Africa, May 1995, p.237-254.

[8] Eckert, C., "On Security Models", Proceedings of the IFIP TC11 12th International Conference on Information Security, Samos, Greece, May 1996.

[9] Flanagan, D., "Java in a Nutshell", O'Reilly & Associates, third edition, 1999.

---

[3] RMI-Patch applied by Microsoft Service Pack.

[10] Gamma, E., Helm, R., Johnson, R., Vlissides, J., "Design Patterns -- Elements of Reusable Object Oriented Software", Addision Wesley Publishing Company, Reading Mass., tenth edition, 1997.

[11] Harrer, A., Herzog, Ch., "SYPROS Going IDLE -- from a Classical ITS to an Intelligent Distributed Learning Environment", in: Proceedings of ICCE '99, 7th International Conference on Computers in Education, p.836-839, Sep. 1999.

[12] Harrer, A., "Both sides of the coin -- blending cognitive and motivational aspects into a tutoring strategy", in: Proceedings of the International Conference on Computers in Education, ICCE97, p.188-195, 1997.

[13] Herzog, Ch., "Cooperation and competition of syntax-oriented and execution-oriented problem solvers in intelligent programming tutors", in: Artificial Intelligence in Education -- Knowledge and Media in Learning Systems, Proc. AI--ED 97, Kobe, Japan, p.309-316, 1997.

[14] —,"Java Native Interface", JDK Documentation, Sunsoft, 1996.

[15] Martha C. Polson, Richardson, J. J., "Foundations of Intelligent Tutoring Systems", Lawrence Erlbaum Associates, Hillsdale, New Jersey, 1988.

[16] —,"Java Remote Method Invocation -- Distributed Computing for Java", Whitepaper, http://java.sun.com/marketing/collateral/javarmi.html, Sun Microsystems Inc., 1999.

[17] —,"Java Remote Method Invocation Specification", Revision 1.50, JDK 1.2, Sun Microsystems Inc., October 1998.

[18] —,"RMI-IIOP Programmer's Guide", http://java.sun.com/products/jdk/guide/rmi-iiop/rmi_iiop_pg.html, Sun Microsystems Inc. and IBM Corporation, 1999.

[19] Rumbaugh, J., Jacobson, I., Booch, G., "The Unified Modeling Language Reference Manual", Addision Wesley Longman, Inc., Reading Mass., Dec. 1998.

[20] Tanenbaum, A. S., "Modern Operating Systems", Prentice Hall Inc., 1992.

[21] McPherson, Scott, "Java Servlets and Serialization with RMI", in: Java Developer Connection, http://java.sun.com/developer/technical/Articles/RMI/rmi/index.html, Maczieg Software, 1999.

[22] —,"The Common Object Request Broker: Architecture and Specification", Object Management Group, Wiley, New York, 1995.

A Java-based Interactive Learning System of Junior High School Level Geometry

Yu-Ru Chen*, Tzyy-Leng Allen Horng, and Don-lin Yang***
**Department of Information Engineering*
***Department of Applied Mathematics*
Feng Chia University
100, WenHwa Rd, Seatwen, Taichung, Taiwan407
**Tel: +886-4-4517250 ext. 3743*
***Tel: +886-4-4517250 ext. 5126*
**Fax: +886-4-4516101*
***Fax: +886-4-4510801*
**E-mail:dlyang@fcu.edu..tw*
***E-mail:tlhorng@math.fcu.edu.tw*

In this paper we propose a Java-based CAI system that provides a learning-by-doing environment with hands-on exercise and instant interaction capabilities on the World Wide Web. Our current topics of interest is the Euclidean geometry for junior high school students. To design the system, we adopt the theory of concept map to construct teaching and learning materials. We are currently testing the system and has observed that it does significantly help students in learning geometry.

Keywords: **CAI, concept map, Euclidean geometry, Java applet**

1 Introduction

As computer science and Internet technology make speedy progress at every moment, computer aided instruction (CAI) plays an important role in our life, especially in future education for global citizens at every corner of the world. Many researches focus on the web-CAI, but there are some drawbacks in these systems:

(1) Some of these systems simply use graphs or animations and text to describe the meanings of the teaching materials. Although this way of displaying is more lively than the traditional textbooks, the learners still need to stare at the screen uncomfortably to read the text thoroughly to understand its meanings. Besides, some subjects such as mathematics need to be learned by practicing with examples.

Plain text reading is just not enough.

(2) Most multimedia web-CAI systems requires high bandwidth, which is still a problem for the current internet infrastructure. Long waiting time for response will definitely degrade the effect of learning no matter how well designed the web-CAI system is.

To demonstrate our ability of conquering the above problems, we have developed a web-CAI system in Chinese (http://www.math.fcu.edu.tw/~tlhorng/geometry) for teaching and learning junior-high-school Euclidean geometry (named just geometry in the following context). Students can have great fun in learning on our system owing to its highly interactive and experiment-oriented features. Besides, the system is designed all using small-size Java applets, and is therefore robust enough to tolerate the usual congestion on the internet.

The rest of the paper is organized as follows: Section 2 introduces our design theories such as the concept maptheory and dynamic geometry method; Section 3 shows the implementation and Section 4 summarizes the whole work and some future enhancement.

2 Theories behind our design

First we employ the concept map theory to plan the curriculum and then apply dynamic geometry method to design the curriculum to be highly interactive, problem-oriented and, most importantly, interesting. In this way, the learners are encouraged to learn by playing with those Java applets, and to construct their knowledge system by concept map theory.

2.1 Concept map theory

In order for learners to make a meaningful learning, Ausubel present a meaningful learning theory [1]. The idea in this theory is that whenever to learn a new concept or a new knowledge it must base on the prior experience. Ausubel's theory considers that the relation between the new concept and learner's prior knowledge plays an important role in the meaningful learning. Whenever the new knowledge, learners' prior concept, and proposition framework are successfully joined, learning is created. In other words, learners can make a meaningful learning by utilizing learners' prior concept to link the new concept to organize the whole knowledge. Novak further presents a concept mapping method for the purpose of verifying Ausubel's theory [1]. Concept map is composed of propositions. Every proposition contains two concept nodes and a relation link between them. In a concept map, concepts are represented in a hierarchical way. A general or summarized concept is put in an upper hierarchy, and a specific or particular concept is put in a lower one. A graph describing the integration of concepts from the lower levels to higher ones and the relation linking among them is called concept map that can represent a knowledge structure effectively.

2.2 Dynamic geometry method

To teach or learn geometry effectively, we usually have the following two aspects in mind [2]: knowledge developing (the deductive method), and knowledge acquiring (the generalizing method).

Both are equally important. However, most of the current geometry curriculum in junior high school has been emphasizing on how to prove a geometric problem by the deductive way, and frequently ignoring how to the generalize a geometry concept by experiments and observation. Our web-CAI system present the curriculum in both ways and particularly emphasizes the latter one.

3 Implementation

In our web-CAI system, the whole curriculum is problem-oriented, and each geometric problem, besides its proof, is designed to be explored by experimentation which is implemented by Java applets. Java applet is selected owing to its full-featured library for designing internet applications and its platform-independent portability [3-5]. The code was written by JDK 1.1 and is entirely in Pure Java™.

3.1 Drawing the concept map

There are four steps to draw the concept map: 1. concept seeking, 2. concept categorization, 3. concept hierarchy, 4. concept relation.

Concept seeking: First list all important concepts to be taught. A concept is the foundation unit stored in the human brain, although everyone may store a same thing by concepts in his own different way. That is why everyone may response differently when seeing or hearing an identical event at the same time. This individual opinion of everybody is called the concept.

Concept categorization: After seeking for concepts, this step is to divide concepts into two parts: event and target. Taking circle as an example in our geometry curriculum, we can list twelve relevant important concepts as categorized in table 3.1

Concept hierarchy: After categorizing the concepts, we further place them into a hierarchy. As mentioned above, a more general concept will be put in a upper level, while a more specific one in a lower level. Figure 3.1 is the hierarchy chart of Table 3.1.

Concept relation: After putting all concepts in a hierarchy, we further denotes those relations among concepts to form a complete concept map. Following the above, the circle's concept map is shown in Figure 3.1.

Event	Target
line	relationship between a circle and a line
chord	relationship between a chord and the diameter
chord and center	relationships between a chord and its distance to center
central angle	relationship between a central angle and a chord
arc	relationship between a chord and a arc
circumferential angle	relationship between a arc and a circumferential angle
tangent	two tangents from an external point to a circle are equal in length
quadrilateral	the opposing angles of a quadrilateral inscribed in a circle is complementary
triangle	three bisectors are concurrent in a triangle
incenter	Distances of the incenter to the three sides of a triangle are equal
two circles	relationship between two circles
two circles and tangent	tow circle' s common tangent

Table 3.1. Concept categorization

3.2 Composing the plan for teaching materials

By the concept map, we can further propose the teaching materials and write down these ideas into a table called the plan of teaching materials. Following the above, Table 3.2 shows a small part of the plan: the relative locations of two circles and their common tangent.

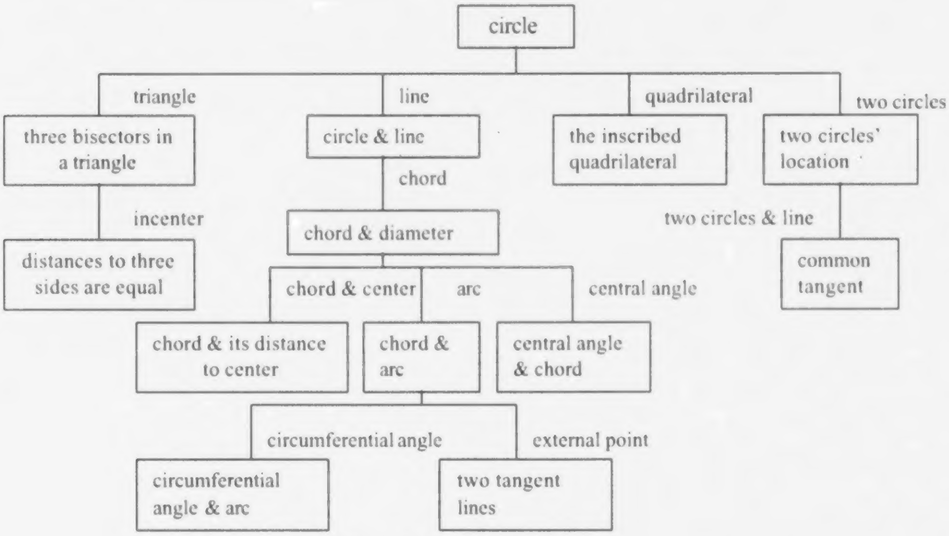

circle
triangle
line
quadrilateral
two circles
three bisectors in a triangle
circle & line
the inscribed quadrilateral
two circles' location
chord
incenter
two circles & line
chord & diameter
distances to three sides are equal
common tangent
chord & center
arc
central angle
chord & its distance to center
chord & arc
central angle & chord
circumferential angle
external point
circumferential angle & arc
two tangent lines

Figure 3.1 Circle' s concept map.

Page	Consist Concept
Circles' locations	There are six kinds of relations for two circles judging from their locations: separated internally, separated externally, tangential internally, tangential externally, intersecting and coincident.
Common tangent	Two circles on a plane can have the following common tangents according to their relative locations: When the two circles are separated externally, there are two external common tangents and two internal ones. When the two circles are tangential externally, there are two external common tangents but one internal one. When the two circles intersect at two points, there are two external common tangents and no internal one. When the two circles are tangential internally, there is only one external common tangents and no internal one. When the two circles are separated internally, there is neither an external common tangent nor an internal one.

Table 3.2 A part of the plan of teaching materials

3.3 Displaying the teaching materials by Java applet

Taking the common tangent of two circles as an example, we display this part of teaching materials by the

Java applet shown in Figure 3.2 (a)-(c). This Java applet is designed that the learner can play around by dragging any center (shown as red dots) of the two circles which will change the distance between these two centers. From the movement, the learner can observe various kinds of common tangents happening for the two circles. If we show it alternatively by some static graph or animation, the learner would have problem catching its meaning effectively.

3.4 The examination module

Besides those Java applets for displaying teaching materials, our web-CAI system also provides an examination module for on-line testing. Through this module, teachers can edit test problems and grade students' answers, and students can take tests and look up for their grades all on our web-CAI system. Four individual applets, in charge of problem editing, examination, grading, and grade looking-up, consist of this examination module. Figure 3.3 particularly shows the problem-editing part, in which teachers can edit a test problem and draw the illustration related to it. Also, all the test problems can be saved in a database server driven by JDBC• Java Database Connectivity. JDBC is a Java-standard SQL database access interface [6]. It provides access to varieties of databases. After teacher edit the examination questions, the students can take the exam on our web-CAI system. On that, students can write down the answers and draw some auxiliary lines on the illustration which may be required for proving a geometric theory or just to help them solve the problem. Teachers can then grade and comment the students' answers, and the students can look up for the grades and teacher's comment later all on our web-CAI system.

4 Conclusions and future work

We have developed a web-CAI system that provides an interactive learning and testing environment on Web. In this way, the learner can learn more effectively than other multimedia-CAI systems. Currently we have chosen Euclidean geometry in junior high school as an example, and plan to extend to other science subjects, the physics and chemistry in the future. Besides, we keep modifying the GUI in our system to be more friendly and interesting. We also plan to choose a junior high school to test our system and evaluate its performance.

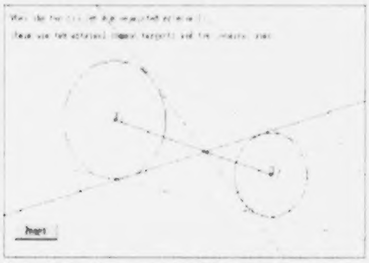


Figure 3.2 (a) A scene of the Java applet of two circles' common tangents. Red points are subject to dragging.

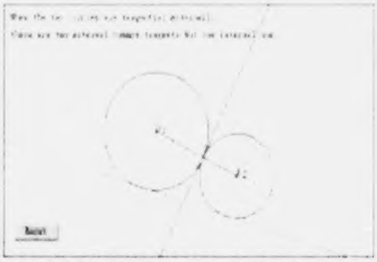


Figure 3.2 (b) Another scene following Figure 3.2 (a). Red points are subject to dragging.

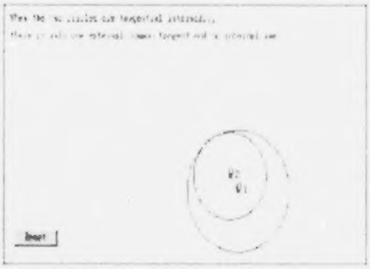


Figure 3.2 (c) Another scene following Figure 3.2 (b). Red points are subject to dragging.

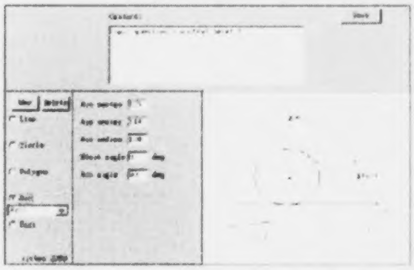


Figure 3.3 Test problem editing part of the examination module.

References

[1] The concept mapping homepage, http://www.to.utwente.nl/user/ism/lanzing/cm_home.htm
[2] Mathematics resources center, National Normal Taiwan University, http://mathsup.math.ntnu.edu.tw/.
[3] Knudsen, "Java 2D Graphics'' , O' Reilly, Cambridge, Massachusetts, (1999).
[4] Arnold and Gosling, "The Java programming language'' , Addison-Wesley, Reading, Massachusetts, (1998).
[5] Deitel and Deitel, "Java : how to program'' , Prentice Hall, Upper Saddle River, New Jersey, (1997).
[6] Reese, "Database Programming With JDBC and Java'' , O' Reilly, Cambridge, Massachusetts, (1997).

A Learner-Centered Navigation Path Planning in Web-based Learning

Akihiro Kashihara, Ryoichi Suzuki, Shinobu Hasegawa, and Jun'ichi Toyoda

The Institute of Scientific and Industrial Research, Osaka Univ., JAPAN
8-1, Mihogaoka, Ibaraki, Osaka 567-0047, JAPAN
kasihara@ai.sanken.osaka-u.ac.jp

The main issue addressed in this paper is how to help learners navigate in existing web-based learning resources. Towards this issue, we introduce a learner-centered navigation path planning. The key idea is to provide learners with a space, in which they can see through WWW pages to plan a navigation path. In this paper, we also demonstrate an assistant system, which is composed of hyperspace map, page previewer, and path previewer. The page previewer generates an overview of each WWW page in the map by extracting representative information from the HTML file. The path previewer helps learners make a sequence of the pages previewed as navigation path plan. These facilities help learners decide which page to visit and plan a navigation path without visiting hyperspace. This paper also describes a preliminary evaluation with the assistant system. The results indicate that the system facilitates learning and navigation in a more complicated hyperspace.

Keywords: Navigation Path Planning, Learner-Centered, Page Previewer, Path Previewer

1 Introduction

An increasing number of hypermedia/hypertext based resources on the Web has been available, which are designed from an educational point of view, or which are worth learning. Learning with such existing web-based learning resources has accordingly become important, particularly as the realization of lifelong and distance learning.

Web-based learning resources provide learners with hyperspace where they can explore domain concepts/knowledge in a self-directed way from a WWW page to others by following the links among pages to achieve a learning purpose. However, learners often fail in making the navigation path since they do not know which link to follow for achieving their learning purpose due to the complexity of hyperspace [3], [9]. They may alternatively reach an impasse due to a cognitive overload, which is caused by diverse cognitive efforts at setting up local learning purposes, comprehending the contents included in nodes, etc., in the exploratory learning [6], [11]. How to facilitate learners' navigation and learning is consequently a major issue in educational hypermedia/hypertext systems [1], [11].

The main topic addressed in this paper is how to help learners navigate in existing web-based learning resources. Current work on educational hypermedia/hypertext systems has provided a number of navigational aids such as spatial/concept maps and adaptive navigation [1], [4], [5]. However, these aids can not be always available to existing web-based learning resources since it is hard to grasp semantic relationships among the WWW pages, on which the navigational aids are founded, without analyzing the contents of the learning resources.

In this paper, we discuss a learner-centered navigation path planning. The key point of this idea is to provide learners with a space, in which they can see through web-based learning resources to make a navigation path plan, apart from hyperspace. Such planning space is also expected to facilitate their learning since they can focus mainly on comprehending the contents of the learning resources in hyperspace. We have accordingly developed an assistant system for the navigation path planning. This system provides learners not only with hyperspace map but also with page previewer and path previewer. The page previewer extracts information attached to some HTML tags in a WWW page, which can be considered representative of the page, from the HTML file, and displays it as an overview of the page. The path previewer also makes a sequence of the pages previewed, and displays it as navigation path plan. These facilities help learners decide which page to visit and make a navigation path plan without visiting hyperspace.

This paper also describes a preliminary evaluation of learner-centered navigation path planning with the assistant system. The results indicate that the system facilitates learners' navigation and learning in hyperspace, particularly in more complicated hyperspace.

Before discussing the learner-centered navigation path planning, let us first consider navigation in hyperspace.

2 Navigation in Hyperspace

2.1 Problems

In hyperspace, learners can explore nodes in a self-directed way by following links among the nodes to learn domain concepts/knowledge embedded in the explored nodes. The exploration involves making a path called navigation path [9]. However, learners can not foresee what they can explore next from the current node and can not decide which link to follow for achieving their learning purpose, often failing to make their navigation path [11]. This is mostly caused by the complexity of hyperspace. The learners may alternatively reach an impasse since they need to concurrently make diverse cognitive efforts at setting up local learning purposes, comprehending the contents explored, etc., in exploratory learning [6], [7], [11].

2.2 Navigation Aids

The important points towards the navigation problem are how to give learners an unobstructed view of hyperspace and how to call their attention to making a navigation path.

As current representative navigational aids, there are spatial maps and concept maps. Spatial maps represent nodes and links that compose the structure of hyperspace [4], [8]. Concept maps consists of nodes and links representing the structure of domain concepts to be learned, which nodes are mapped on the corresponding nodes in hyperspace [5]. In both of spatial and concept maps, nodes are tagged with their titles, which are intended to represent the contents of the nodes. In concept maps, links are also tagged with descriptions representing the semantic relationships between the nodes. Although such tag information may be insufficient for learners to make a navigation path plan, the spatial and concept maps provide learners with a space, apart from hyperspace, for considering navigation paths.

Another solution to the navigation problem is adaptive hypermedia, which supports navigation in hyperspace by annotating nodes and links to be visited, hiding nodes and links not to be visited, etc [1]. Such adaptive navigational aids are founded on semantic relationships among domain concepts/knowledge and learners' exploration status.

These above representative navigational aids would generally work well in educational hypermedia/hypertext whose semantic structure has been given or analyzed [2]. However, it is doubtful whether they apply to web-based learning resources [12]. Existing web-based learning resources mostly have no concept maps. It is also hard to identify semantic structure of domain concepts/knowledge embedded in the learning resources. Although there are web-based learning resources with site maps, the anchors included in the maps do not always allow learners to foresee the contents of the WWW pages. In addition, adaptive navigational aids are not always applicable since existing web-based learning resources generally have no clear description of semantic relationships among WWW pages, which is indispensable for executing the adaptation. In order to apply these navigational aids to existing web-based learning resources, it is necessary to analyze semantic structure of the domain concepts/knowledge beforehand. In this paper, however, we address the issue of how to support learners' navigation without the analysis.

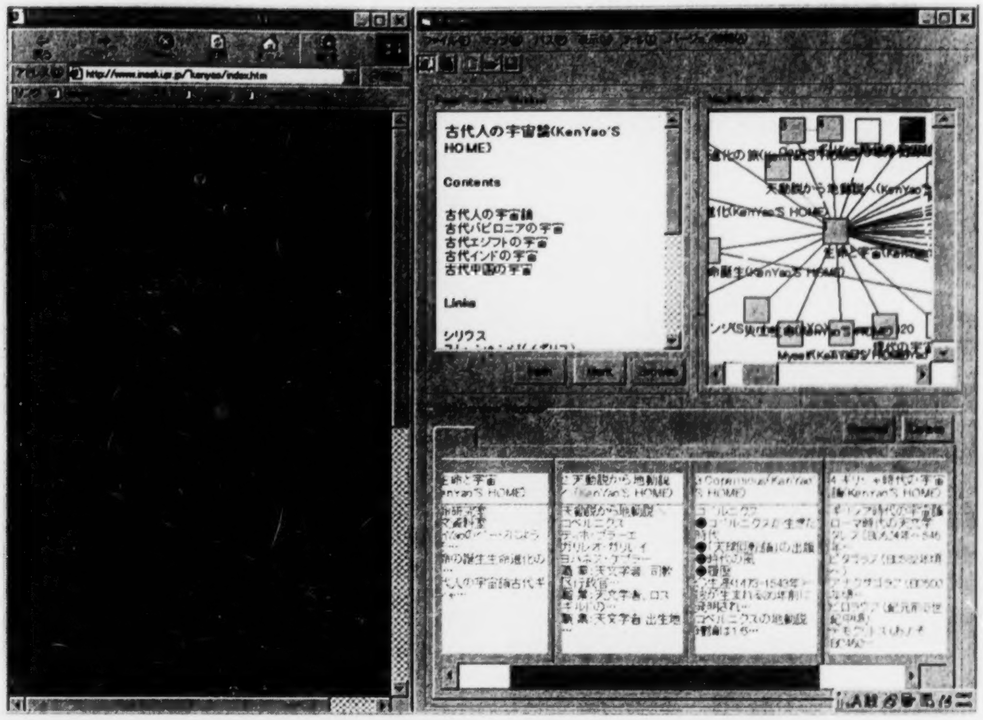
2.3 Navigation Path Planning and Execution

Let us now introduce a learner-centered navigation path planning. The key idea is to provide learners with a space where they can plan a navigation path with an overview of each WWW page. In other words, learners have two spaces, which are space for navigation path planning and hyperspace for executing the plan. In the planning space, learners decide which page to visit and the sequence of pages visited. In the hyperspace, they are expected to explore hyperspace as planned. The navigation path planning and plan execution are repeated during learning in hyperspace.

The distinction between navigation path planning and plan execution allows learners to focus mainly on comprehending the contents of learning resources in hyperspace. Since the navigation path plan also gives learners an overview of the contents to be learned before exploring hyperspace, their learning can be improved.

3 Learner-Centered Navigation Path Planning

We next discuss how to support learner-centered navigation path planning and demonstrate an assistant system that has been already implemented.



古代人の宇宙観(KenYao'S HOME)

Contents

古代人の宇宙観
古代バビロニアの宇宙
古代エジプトの宇宙
古代インドの宇宙
古代中国の宇宙

Links

シリウス

Figure 1. User Interface.

3.1 Framework

Let us first consider what kind of information should be presented for supporting navigation path planning. Although spatial maps of web-based learning resources are necessary for considering navigation paths, the maps alone may be insufficient for learners as mentioned above. It is indispensable to provide them with some additional information. However, planning with the full contents of the WWW pages causes the same navigation problem as hyperspaoe usually produces. This suggests the necessity to give learners an informative overview of the contents. In this paper, we introduce a page previewer that tries to extract keywords, sentences, or images to be considered representative from a WWW page to display them as the preview of the page.

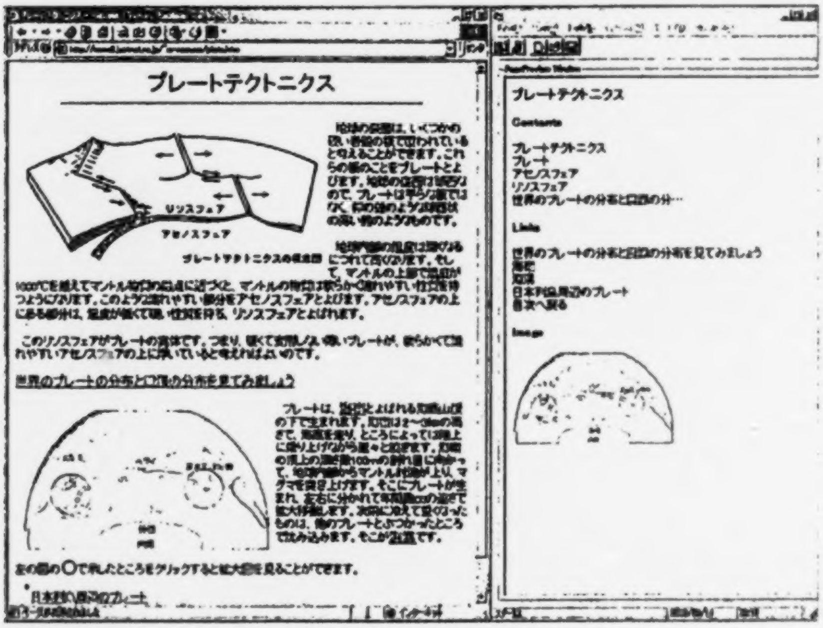
In addition, the navigation path planning involves considering the relationships between WWW pages explored, changing the plan, and replanning over again. We accordingly introduce a path previewer that makes a sequence of the previewed pages the learners want to visit. The path previewer helps the learners plan, change, and remake navigation path with the sequence of the previewed WWW pages.

Figure 1 shows a user interface of the assistant system for learner-centered navigation path planning. The system is composed of spatial map, page previewer, and path previewer. The spatial map represents hyperspace of a web-based learning resource selected by learners as network of nodes corresponding to the WWW pages. It is automatically generated and displayed in the map window when they select the learning resource. The spatial map represents the WWW pages only within the same WWW site where the homepage selected by the learners is located. The links from the site to others are omitted. Nodes in the spatial map are tagged with page titles indicated by title tags in the HTML files.

In the spatial map, the node corresponding to the WWW page learners currently visit with browser is colored with red. The learners can start planning a navigation path from the current node by following the links. The path planned is restricted by the structure of the spatial map. In left mouse-clicking a node, they can have an overview of the WWW page corresponding to the clicked node in the page preview window. The color of the node previewed is also changed into red. Nodes next to the red node are also colored as yellow. If it is hard to see connections between the red node and the next nodes, a pop-up menu including the titles of the next nodes appears by means of right mouse-clicking the red node. Selecting one title from the menu, learners can see an overview of the corresponding node in the page preview window.

Table 1. HTML Tags Searched.

HTML Tags	Meanings
- About contents	
1.Title	Title of page
2.H1 to H3	Headings of page
3.Font Size/Color/Face	Font size, color, and figure
- About links	
A href	Link to another page
- About images	
Img	Image file



プレートテクトニクス

プレートテクトニクス

Contents

プレートテクトニクス
プレート
アセノスフェア
リソスフェア
世界のプレートの分布と[illegible]の分…

Links

世界のプレートの分布と[illegible]の分布を見てみましょう
[illegible]
[illegible]
日本列島周辺のプレート
目次へ戻る

Image

Figure 2. An Example of Page Preview.

The learners can also put the previewed node in the path preview window, making a navigation path plan. The learners are expected to explore hyperspace as planned with browser. When they want to change or cancel the navigation plan during the exploration, they can return to the navigation path planning windows and remake a new path.

In the following, let us explain the page previewer and path previewer in more detail.

3.2 Page Previewer

The important point to generating an overview of a WWW page is how to extract information representing the contents of the page. Assuming that such information is located with the HTML tags shown in Table 1, the page previewer extracts words, sentences, or images indicated by these tags to display them as page preview. We heuristically consider such assumption valid. Figure 2 shows an example of the page preview. The right window shows the preview of a WWW page shown in the left window.

The information extracted from a WWW page is classified into the contents, the links out of it, and images included. As for the contents, the page previewer searches for the HTML tags in order from top to bottom in Table 1, and extracts words or sentences attached to the tags. When extracting a sentence, it displays not all words but

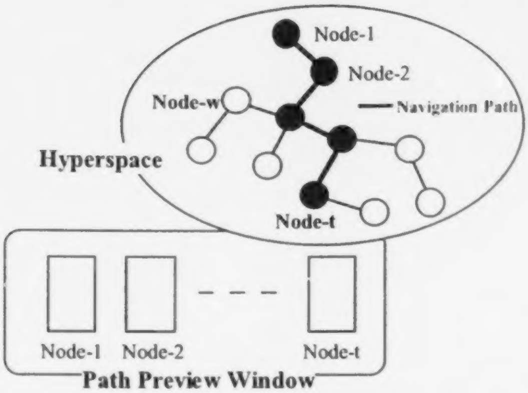


Figure 3. Restriction on Navigation Path Planning.

fifteen words from the head of the sentence. If the number of HTML tags included in the HTML file is large, the page previewer deals with ten HTML tags that are searched from the top in Table 1. For example, let us consider a WWW page including a large number of HTML tags such as one title tag, six *H1* tags, seven *H2* tags, nine *H3* tags, etc. In this case, the page previewer focuses on ten tags, which are the title, six *H1* and three *H2* tags, and displays the information attached to these tags.

As for the links out of the page, the page previewer searches for *A href* tags in the HTML file to display the descriptions of the links. If the descriptions indicate the URL, they are not displayed. If the number of *A href* tags is large, the page previewer displays only five link descriptions to be found from the head of the HTML file. As for the images included in the page, the page previewer searches for *Img* tags in the HTML file, and displays one image whose file size is the largest.

Learners can see the preview of a WWW page by mouse-clicking the corresponding node in the spatial map. Since the node previewed is colored with red, they know where they are previewing in the spatial map. If they can not foresee the contents of the page, they can push the *Browse* button under the page preview window or double-click the node to look at the full contents in browser. However, these operations are not recommended in planning. In making a navigation path plan, the learners can include the node previewed in their navigation path by pushing the *Path* button. Mouse-clicking the *Mark* button, in addition, they can mark the node previewed, which they do not want to immediately put in the path preview but to memorize.

3.3 Path Previewer

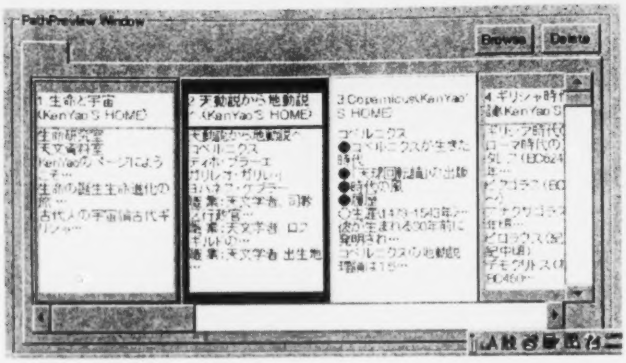
In the path preview window, the path previewer sequences the nodes previewed, which nodes are put in order by learners. The order of the previewed nodes represents a navigation path plan. The adjacent nodes are also adjacent each other in hyperspace. If the learners attempt to put a node in the sequence, which is not directly linked to the tail node of the sequence in hyperspace, the path previewer disables the *Path* button. For example, let us consider a learner who works out a navigation path plan as shown in Figure 3. If he/she tries to put *Node-w* in the plan, he/she is provided with a warning from the path previewer since the *Node-w* is not linked to the tail node (*Node-t*) of the sequence in hyperspace. In this way, the navigation path planned has to follow the link structure of hyperspace.

The learners can also delete any node in the navigation path plan by mouse-clicking it and selecting *Delete* button in the upper right corner of the path preview window. In order to help learners select one of some branches from a node, the page previewer additionally displays these branches with some path preview windows concurrently.

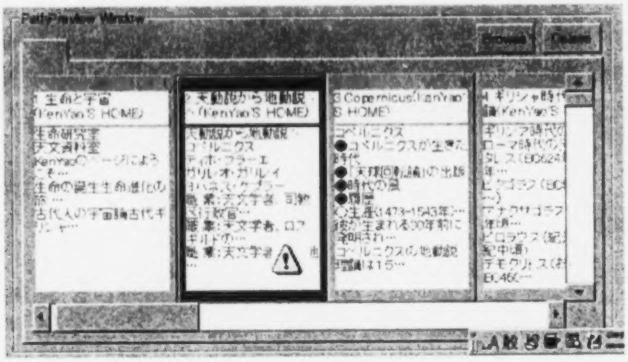
3.4 Plan Execution and Replanning

Using the page preview and path preview windows, learners are expected to decide a navigation path and then to start exploration in hyperspace. They are also expected to follow the navigation path plan during the exploration. The node in the plan corresponding to the WWW page, which the learners currently browse, is framed with blue. This allows them to know which node they are browsing. When they put the mouse-cursor on a link in the WWW page, which link indicates the node next to the framed node, the node is also framed with yellow such as Figure 4(a). This also allows them to know which link to follow in the WWW page.

The learners do not always need to follow the plan. They can explore nodes with browser, which are not included



(a) Attention to Next Page.



(b) Warning.

Figure 4. Attention and Warning in Path Preview Window.

in the plan. As shown in Figure 4(b), however, the path previewer put a warning icon on the node at which the learners run off in the plan. When they also want to change or cancel the navigation plan during the exploration, they can return to the navigation path planning windows and remake a navigation path plan from the node corresponding to the current page on browser.

In this way, learners are expected to repeat the navigation path planning and plan execution to accomplish the exploratory learning in hyperspace.

4 Preliminary Evaluation

4.1 Experiment

In order to evaluate the effectiveness of learner-centered navigation path planning with the assistant system, we have had a preliminary experiment. The main purpose of this experiment was to ascertain if navigation path planning with the system facilitates navigation and learning in hyperspace compared to navigation and learning without the system. We also prepared two learning resources, which had comparatively simple and complicated hyperspace, and ascertained for which resource the system can assist in navigation and learning more effectively.

Table 2 shows the two learning resources, which describes the number of pages, the number of links per page, which was calculated except for navigation links such as *Next*, *Back*, and *Top*, and the longest distance from the homepage to terminal page that has no link. These can be viewed as the indicators of the complexity of hyperspace each learning resource provides. The learning resource 2 accordingly had a more complicated hyperspace. Subjects were 7 graduate and undergraduate students in science and technology.

We set four conditions, which were (1) planning and execution with the system in the learning resource 1 (*Simple-With*), (2) exploration in the learning resource 1 without the system (*Simple-Without*), (3) planning and execution with the system in the learning resource 2 (*Complicated-With*), and (4) exploration in the learning resource 2

Table 2. Learning Resources.

	Learning Resource 1	Learning Resource 2
Number of Pages	32	161
Number of Links per Page	1.2	2.2
The Longest Distance from Homepage to Terminal Page	3	7

Domain of learning resource 1: Life and space.
Domain of learning resource 2: Life in sea.

Table 3. Average Scores of Problem-Solving.

Condition	Total	Single Problems	Compound Problems
Simple-With	75%	100%	60%
Simple-Without	71%	78%	67%
Complicated-With	79%	83%	75%
Complicated-Without	62%	78%	50%

Table 4. Average Scores of Revisit per Page.

	Revisit		Revisit
Simple-With	1.58	Complicated-With	1.83
Simple-Without	1.56	Complicated-Without	4.04

without the system (*Complicated-Without*). Subjects were provided with Microsoft Internet Explorer as WWW browser under each condition. In this experiment, each subject learned one learning resource without the system and learned the other with the system. In other words, he/she was assigned two conditions, which were *Simple-With* and *Complicated-Without* (or *Simple-Without* and *Complicated-With*).

Before learning, subjects were given several problems as learning purposes for each learning resource. The problems were classified into (1) single problems whose answers could be found within one WWW page, and (2) compound problems whose answers could be found in the relationships among two or three pages. In this experiment, the effects on learning were measured by the scores on both problems. The effects on navigation in hyperspace were measured by the number of revisiting pages in hyperspace [10]. The time of learning in each condition was limited to thirty minutes.

The procedure of the experiment with each subject was as follows:

(1)The subject was given the explanation about how to use the assistant system before learning and then single and compound problems for the learning resource 1 or for learning resource 2.

(2)He/she was required to explore answers to the problems. In *Simple-With* or *Complicated-With*, he/she was next required to use the assistant system for making a navigation plan and to use the WWW browser for exploring hyperspace. In *Simple-Without* or *Complicated-Without*, he/she was next required to use only the WWW browser to explore hyperspace. In each condition, he/she was provided with a space where he/she can copy and paste the contents of the WWW page considered as the answers.

(3)When he/she finished finding out the answers or thirty minutes passed, the contents copied and pasted by him/her was checked and the scores was calculated as the percent of corrected answers. The number of revisit per explored page was also checked.

Comparing the scores and the numbers of revisit per page explored under *Simple-With* and *Simple-Without* or under *Complicated-With* and *Complicated-Without*, we evaluated the effectiveness of the assistant system.

4.2 Results and Discussion

Table 3 shows the average score on each condition. The average score (75 %) on *Simple-With* was slightly higher than the average score (71 %) on *Simple-Without*. On the other hand, the average score (79%) on *Complicated-With* was considerably higher than the average score (62 %) on *Complicated-Without*. The difference between the average scores in the compound problems on *Complicated-With* and *Complicated-Without* was particularly large.

Table 4 shows the average number of revisit per page explored on each condition. Although the difference between the average numbers of revisit on *Simple-With* and *Simple-Without* was very small, there was a great difference between the average numbers of revisit on *Complicated-With* and *Complicated-Without*.

The above results indicate that the assistant system produced good effects on learning such as integrating the contents of some pages in a more complicated hyperspace. As for effects on navigation, the system facilitated navigation in a more complicated hyperspace. In a simpler hyperspace, on the other hand, the assistant system could not be so fruitful since it was able to easily see through the learning resource even without the system. Although we need a detailed experiment with more subjects, the assistant system can effectively help learners navigate and learn in a complicated hyperspace.

5 Conclusion

This paper has proposed a learner-centered navigation path planning for learning with existing web-based resources. The important point is to provide learners with a space where they can see through WWW pages to make a navigation path plan. As the advantages, learning in hyperspace can be improved since the distinction between navigation path planning and plan execution allows learners to focus mainly on comprehending the contents of the learning resources in hyperspace. The navigation path plan can also give learners an overview of the contents to be learned before exploring hyperspace.

This paper has also demonstrated an assitant system including page previewer and path previewer. These previewers allow learners to decide which page to visit and make a navigation path plan without visiting hyperspace. In addition, this paper has described a preliminary evaluation of the learner-centered path planning with the system. The results indicate that the system produces good effects on learning and navigation in a complicated hyperspace.

In the future, we need a more detailed evaluation of the learner-centered navigation path planning. We would also like to provide more adaptive aids in the page and path previews.

References

[1] Brusilovsky, P. Methods and Techniques of Adaptive Hypermedia, Journal of User Modeling and User-Adapted Interaction, 6, (1996) 87-129.

[2] Brusilovsky, P., and Eklund, J. A Study of User Model Based Link Annotation in Educational Hypermedia, Journal for Universal Computer Science, Vol.4, No.4, pp.429-448 (1998).

[3] Conklin, J. Hypertext: An Introduction and Survey, Computer 20, 9 (1988), 17-41.

[4] Domel, P. WebMap - A Graphical Hypertext Navigation Tool, in Proc. of Second International WWW Conference (1994), http://www.ncsa.uiuc.edu/SDG/IT94/Proceedings/Searching/doemel/www-fall94.html.

[5] Gaines, B.R. and Shaw M.L. G. WebMap: Concept Mapping on the Web, in Proc. of Second International WWW Conference (1995), http://www.w3.org/Conferences/ WWW4/Papers/134

[6] Kashihara, A., Uji'i, H., Toyoda, J. Visualizing Knowledge Structure for Supporting Exploratory Learning in Hyperspace , in Proc. of HCI International 99, pp.667-671 (1999).

[7] Kashihara, A., Uji'i, H., and Toyoda, J. Reflection Support for Learning in Hyperspace, Educational Technology, Vol.39, No.5, pp.19-22 (1999).

[8] Mukherjea, S., Foley, J., and Hudson, S. Visualizing Complex Hypermedia Networks through Multiple Hierarchical Views, in Proc. of ACM SIGCHI 95 (1995).

[9] Nielsen, J. The Art of Navigating Hypertext, Communication of the ACM, 33, 3 (1990), ACM Press, 297-310.

[10] Tauscher, L., and Greenberg, S. How people revist web pages: empirical findings and implications for the design of history systems. International Journal of Human-Computer Studies, 47, 1 (1997), 97-137.

[11] Thuering, M., Hannemann, J., and Haake, J.M. Hypermedia and Cognition: Designing for Comprehension. Communication of the ACM, 38, 8 (1995), ACM Press, 57-66.

[12] Zeiliger, R., Belisle, C., and Cerratto, T. Implementing a Constructivist Approach to Web Navigation Support, in Proc. of World Conference on Educational Multimedia and Hypermedia '99 (1999).

A Methodology for Learning Pattern Analysis from Web Logs by Interpreting Web Page Contents

Chih-Kai Chang and Kuen-Shan Wang
Department of Information Management
Da-Yeh University
Da-Tsuen, Chang-Hwa 51505 Taiwan, R.O.C.
E-mail: chihkai@mail.dyu.edu.tw

As Web-based course become popular, the Web system accumulates a large amount of log data. Because the log data was generated by learners' behavior on the Web-based course, many researchers agree that analyzing the Web log will bring benefits for learners, instructors, and the Web site manager. In general, one record of Web log can indicate "which Web page was accessed", "who access that Web page", and "when the Web page was accessed". Although many interesting results can be derived merely depending on the general Web log, some important meanings of the Web log were not considered in previous researches. In other words, the content, represented by the Web page, is not included in the general Web log. For instance, a Web page may present homework, a discussion article, a section of curriculum, or a grade reports. However, previous research did not consider the represented content of a Web page in the Web log, in which only the file name of the accessed Web page is generally identified. This paper use data mining technology to analyze learners' online behaviors for mining learner's patterns by transforming general Web log to a content perspective. Hence, the methods of previous research still can be used to find the more meaningful results. Most important of all, our methodology finds patterns based on learning behaviors instead of browsing behaviors.

Keywords: **Web-based course, Web log, Data mining technology.**

1 Introduction

As Web-based course becomes popular, various learning activities can be running on the Web [1]. The asynchronous discussion activity, homework assignment and submission, announcement, and grade reports all can be executed on the Web. Because all the learning activities are represented as Web pages, the Web server will accumulate a large amount of log data for every Web page. Basically one record of the Web log can indicate which page was access by someone in sometime. Hence, many researches analyzed the Web server log to figure out users' motivation, users' response, browsing pattern, and the network traffic [2, 3, 4]. Furthermore, analyzing students' on-line learning behaviors and on-line problem solving activities can also discovery meaningful results [5].

There are at least 116 products of Web log analysis for commercial web sites [6]. The technologies used for analyzing Web server log evolve from traffic-based or time-based assessment to user access pattern analysis. For example, Perkowitz uses access patterns to construct an adaptive Web site [7]. Hence, the interested Web pages will be linked and organized as a proper view for every user according his/her access patterns. The *path* concept, users' sequential Web page access records, is important for constructing user access pattern for Web logs. For instance, Stuart Schechter [8] create users' path profile to predicate users' browsing behavior. Consequently, the field of Web log analysis is growing for the purpose of custom services.

Recently, applications of Web log analysis integrate data mining techniques to focus on the customer behavior patterns. It is because the predictive modeling and link analysis operations in data mining techniques can be used to answer questions such as "Which of my customs will prove to be good, long-term valuable customers and which will not?", "How can I sell more to my existing customers?", "Is there a recognizable pattern in which my customers acquire products or use services so I can market to them just-in-time?", and so on [9]. Consequently, we intuitively apply data mining techniques to Web log analysis of an instructional Web site.

For Web-based instructors, their requirements for Web log analysis differ from managers of commercial sites. One of the reasons is as Raphen Becker said, "Because many existing systems are targeted toward commercial webs, the answer is yes, course webs require different systems. One reason is simple: most instructors (and even institutions) cannot afford the commercial products, which are priced toward industry and not towards academia."[10]. Although researchers realize the differences between course webs and commercial sites, the proposed methodology for Web log analysis still inheritance from the Web logs analysis products for commercial sites. For instance, Clio project pays efforts to answer the questions such as "What are the more popular parts of the course web?", "How do readers reach particular pages?", and "Can they quickly reach the pages they want?" so on. Unfortunately, most questions of that kind can be answered by existing Web logs analysis products.

When analyzing Web logs of a course Web, we concern that one encounters what specific problems, which can not be answered by existing Web logs analysis products. In other words, only the learning characteristic of the Web-based learning environment can originate the specific problems. Our previous research focus on providing various summary report for Web instructor to solve that problems, which can not be answered by Web log analysis, from any perspectives [11]. Hence, the questions, which a instructor may ask, should be "What are the meanings of the more popular parts of the course web in learning hierarchy?", "What is the concept that leads learners to reach particular pages?', and "Can learners quickly reach the learning goals by reorganizing Web pages?' so on. In other words, the reports of existing Web logs analysis products should be interpreted to mining the pedagogical meanings by instructors, instructional designers, Web designers, and course web architects. Consequently, it is necessary to propose methodology for discovering learner (not user) access pattern in the Web-based course.

To mining the pedagogical meanings from Web logs, the first requirement is to understand the content of every Web page. In other words, the instructor of the Web course not only need to know ' who accessed the Web page', ' when the Web page is accessed', and ' from where the learner come', but also should know ' what the Web page contains'. However, it is difficult to represent the content of a Web page with symbols. The reason is that the content of a Web page may contain many concepts. Consequently, the first step for understanding the pedagogical meaning is reconstructing the Web pages in the site of a Web-based course by endowing only one topic or concept for each Web page. While breaking a Web page into single concept Web pages, one would find that some concepts are not atomic concepts. That is because a major concept will contain many sub concepts. Hence, the second step for understanding the pedagogical meaning of a Web page is to identify its location within a concept hierarchy instead of its location within the hypertext hierarchy.

The second requirement for discovering learners' learning pattern is to mining sequential access paths on previous aforementioned concept hierarchy. Although there are methodologies to reconstruct navigating paths of users' behaviors on a Web site, that information is not enough for a Web instructor to make some pedagogical decisions. The users' access (behavior) pattern can only help Web site manager improving Web site schema because a Web instructor still can not figure out learners' intention merely by analyzing Web logs without supports of the Web page content. The proposed concept hierarchy presents a feasible style for supports of interpreting the Web page content. After learners' navigating paths on a Web site are transforming to navigating paths on the concept hierarchy, a Web instructor can comprehensive how learners learn from the information of what learners read.

This paper proposes a methodology to mining learners' learning pattern by transforming learners' Web page access sequences to sequences of learning a concept in Web logs. The methodology is supported by traditional web logs mining algorithms, which is designed for discovering users' access pattern on a Web site. This methodology is not used to replace traditional web logs mining algorithms nor is arguing that concept hierarchy is a suitable web site schema. Rather, this methodology presents a framework for integrating traditional web logs mining algorithms with pedagogical meanings of web pages to support Web instructor get more feedback from learners' navigation on the Web course site. Broadly speaking, this methodology contribute to apply traditional web logs mining algorithms to a specific domain in the technical aspect and progress assessment skills in the Web-based distance learning aspect.

2 Illustrative Example

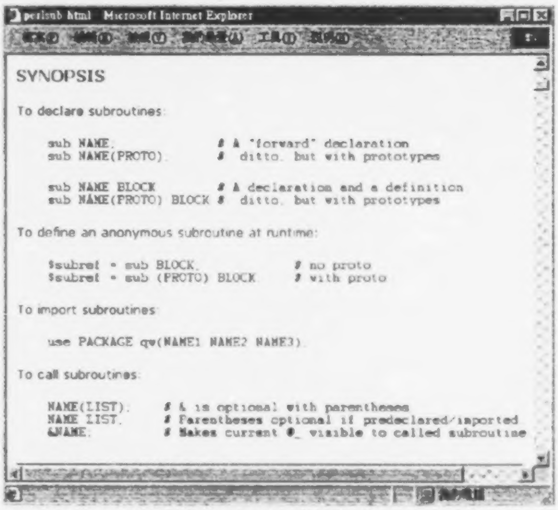
In overview, there are two steps in this illustrative example of detecting learning status. The first step is data preparation. We design a sophisticate structure of a Web site so that we can recognize the content of the accessed Web page. The second steps will find pedagogical meanings from the contents of the preferred Web pages. In this illustrative example, the result of step two will show that learner is not familiar with the learning topic.

2.1 Data Preparation

The required data was collected from the students in an undergraduate course of Perl programming. Perl is a high-level programming language written by Larry Wall. Perl is a very popular programming language for system administrators and CGI script authors. After a brief introduction of Perl, students were asked to study the Web pages extracted from Perl manual. There are three topics in the prepared Web pages. First topic of Web pages demonstrates how to execute the Perl interpreter, called *Perlrun* in Perl manual. Second topic of Web pages explains the Perl model for declaring importing, and calling a subroutine, called *Perlsub* in Perl manual. Third topic of Web pages describes associativity and precedence of Perl operators, called *Perlop* in Perl manual. Consequently, learners' behaviors recorded by Web logs can be recognized by the topic of accessing Web page.

Synopsis and description compose each topic of Web pages. Synopsis is a summary of a topic and generally contains no more than one page. Figure 1 illustrates the synopsis of the Perlsub topic. Description explains the details of a topic in original Perl manual. For illustration, description for each topic was reorganized into two Web pages. In general, synopsis of a topic is prepared for learners who are familiar with that topic. Learners who are learning a topic will prefer the description of that topic. Hence, we can help a learner just in time if he/she is always looking around the description of a topic.

Aforementioned structure is content structure of learning materials. To present learning materials in a hypertext style, a hyperlink structure is required. We use the full connection style to link all Web pages so that learners can navigate to any destination in any Web page.



SYNOPSIS

To declare subroutines:

```
    sub NAME;                 # A "forward" declaration
    sub NAME(PROTO);          #  ditto, but with prototypes

    sub NAME BLOCK            # A declaration and a definition
    sub NAME(PROTO) BLOCK #  ditto, but with prototypes
```

To define an anonymous subroutine at runtime:

```
    $subref = sub BLOCK;                 # no proto
    $subref = sub (PROTO) BLOCK;         # with proto
```

To import subroutines:

```
    use PACKAGE qw(NAME1 NAME2 NAME3);
```

To call subroutines:

```
    NAME(LIST);       # & is optional with parentheses
    NAME LIST;        # Parentheses optional if predeclared/imported
    &NAME;            # Makes current @_ visible to called subroutine
```

Figure 1. Synopsis of Perlsub.

Figure 2 shows the concept structure of the learning materials on the Web site. The notation P_i indicates the Web pages. Although the overview structure is composed of concept hierarchy and contents of learning materials without hyperlink information, the tree structure above the P_i can be used to interpret the content in the page. For instance, the P_l belongs to concept synopsis, which is the partial content of the Perlrun topic.

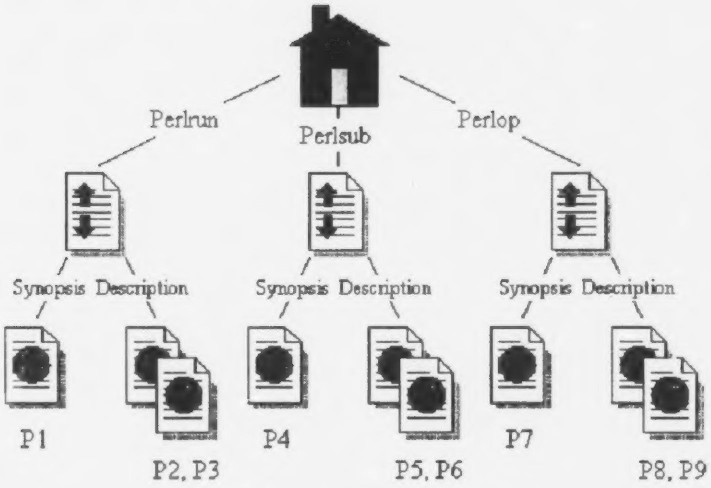


Figure 2. The concept hierarchy of a Web site.

2.2 Mining Processes

There are three learning topics in the Web site, denoted as Perlrun, Perlsub, and Perlop. Each learning topic has two sub concepts, denoted as synopsis and description. The word "synopsis" is used to indicate the Web page for summarizing a topic and the word "description" represents the Web pages that explain a topic in detail. There is an index Web page linking every Web pages to serve as communicating interface with learners. Hence, learners can study any topic in any order through the index Web page. Assume that there is a learner who prefers the "description" Web pages of any topic. In other word, that learner is not familiar with all topics. Hence, the logs of that learner' s browsing behavior on the Web site may be like the sequence:

p2, p3. p2, p8, p9. p5, p8. p5, p1. p2, p5, p6

Because learning can happen in any time, only time nearly browsing behaviors will be related in a learning pattern. Hence, the transaction idea, used in database theory, is involved to cluster learners' browsing behavior. The T*i* means a transaction of the learner' s browsing behavior.

T1: p2, p3
T2: p2, p8, p9
T3: p5, p8
T4: p5, p1
T5: p2, p5, p6

The content of every Web page can be interpreted as a pair of topic and representation style. For instance, p2 belongs to topic Perlrun and is a description of the topic. Hence, p2 is interpreted as (Perlrun, description). After interpreting the transaction data of learner' s behavior, the results are follows.

T1: (Perlrun, description), (Perlrun, description)
T2: (Perlrun, description), (Perlop, description), (Perlop, description)
T3: (Perlsub, description), (Perlop, description)
T4: (Perlsub, synopsis), (Perlrun, synopsis)
T5: (Perlrun, description), (Perlsub, description), (Perlsub, description)

Most of algorithms for mining pattern are derived from aprior [12]. We divide the problem of discovering multi-dimension learner access pattern into four sub procedures, that is litemset phase, transformation phase, sequence phase, maximal phase. Hence, we can use the aprior algorithm for mining pattern. We use the illustrative example to depict the four sub procedures. The litemset phase will generate the large-1 itemset as Table 1.

ID	Large-1 itemset	Support
1	(Perlrun, ‘ *’)	3
2	(Perlsub, ‘ *’)	3
3	(Perlop, ‘ *’)	3
4	(‘ *’ , description)	4
5	(Perlrun, description)	3
6	(Perlsub, description)	3
7	(Perlop, description)	2

Table 1. Large-1 itemset.

The transformation phase use the feasible IDs of items in the large-1 itemset to substitute items in the transaction of learners’ behavior. For instance, the (Perlrun, description) in T1 can be substituted by (Perlrun, ‘ *’), (‘ *’ , description), or (Perlrun, description). Hence, the set of feasible IDs is {1, 4, 5}. The result after the transformation phase is following.

T1: {1, 4, 5}, {1, 4, 5}
T2: {1, 4, 5}, {3, 4, 7}, {3, 4, 7}
T3: {2, 4, 6}, {3, 4, 7}
T4: {2, 4, 6}, {1}
T5: {1, 4, 5}, {2, 4, 6}, {2, 4, 6}

The problem is simplified to mining sequential patterns after the transformation phase [13]. Consequently, the sequence phase can generate the large-2 itemset and larget-3 itemset as Table 2 and Table 3.

Large-2 itemset	Support
{1, 4}	3
{2, 4}	2
{4, 3}	2
{4, 4}	3
{4, 7}	2
{5, 4}	3
{6, 4}	2

Table 2. Large-2 itemset.

Large-3 itemset	Support
{1, 4, 4}	2
{4, 4, 4}	2
{5, 4, 4}	2

Table 3. Large-3 itemset.

Finally, the maximal phase will find the most meaningful pattern from large-2 itemsset and large-3 itemset. Initially, the union of large-2 itemset and large-3 itemset is used as the result. Then, some items will be eliminated because they are the subsets of some larger items. For instance, the meaning of {5, 4, 4} is more than its subset {5, 4} and {4, 4}. Hence, the large-2 items, {5, 4} and {4, 4}, will not be deleted from the initial result. Finally, some items will be eliminated because they are less meaningful then items in the result. For instance, the {4, 3} will be deleted because {4, 7} implies {4, 3}. Similarly, the {2, 4} will be deleted because {6, 4} implies {2, 4}. The following table illustrates the result.

Maximal itemset	Real patterns	Support
{6, 4}	{(Perlsub, description), (‘ *’ ,description)}	2
{4, 7}	{(‘ *’ , description), (Perlop, description)}	2
{5, 4, 4}	{(Perlrun, description), (‘ *’ ,description), (‘ *’ , description)}	2

Table 4. Maximal itemset.

3 Conclusion

The Web-based learning environment offers opportunities to precisely observe learning processes. However, it is tedious for a Web instructor to discovery useful information from the huge amount of Web logs. Traditionally, a Web instructor uses the Web logs analysis products to realize the unusual parts of a Web site. From the pedagogical standpoint, the results of the Web logs mining algorithms are not very useful for figure out learners' learning process because the contents of Web pages are not considered. This paper proposes a methodology to mining learners' learning pattern, which is related with the Web page contents, from Web logs. The methodology uses Web logs mining algorithms, which is used in Web logs analysis products, and the concept structure embedded in Web pages to mining patterns with pedagogical meanings, so called learning patterns. In our opinions, this methodology presents a framework for integrating traditional web logs mining algorithms with pedagogical meanings of web pages to support Web instructor figure out learners' navigation on the Web course site from the concept hierarchy perspective. Consequently, the approach presented here may be not only a feasible application of traditional web logs mining algorithms, but also a possible direction of Web-based learning assessment research.

Acknowledgements

This project is supported by the National Science Council in Taiwan under contract number NSC 89-2511-S-262 -001.

References

[1] C.K. Chang and G.D. Chen. Constructing Collaborative Learning Activities for Distance CAL Systems. Journal of Computer Assisted Learning, Vol. 13, No. 1, pp. 2-15, March 1997.

[2] R. Fuller and J. de Craaff. Measuring user motivation from server log files. In http://www.microsoft.com/usability/webconf/fuller/fuller.htm

[3] T. Sullivan. Reading reader reaction: A proposal for inferential analysis of web server log files. In Proc. Third Conf. Human Factors on the Web, Denver, Colorado, June 1997.

[4] Sun, C. T. & Ching, Y. T. (1995). Hypermedia Browsing Pattern Analysis. International Journal of Education Telecommunications, 1(2-3), 293-308.

[5] Jihn-Chang J. Jehng. Exploring Learning Potentials in Network-enhanced Learning Environment. In Proc. of ED-MEDIA 99, Seattle, Washington, USA, 1999.

[6] Internet Product Watch (1999). Internet Product Watch: Analysis Products. Online document at http://ipw.internet.com/analysis/index.html (accessed March 25, 1999; no creation or modification date available).

[7] M. Perkowitz and O. Etzioni. Adaptive sites: Automatically learning from user access patterns. In Proc. 6th Int. World Wide Web Conf., Santa Clara, California, April 1997.

[8] Stuart Schechter, Murali Krishnan, Michael D. Smith, Using path profiles to predict HTTP requests. Computer Networks, (30)1-7, pp. 457-467, 1998.

[9] Peter Cabena, et al. Discovering data mining: from concept to implementation. Prentice-Hall, Inc.

[10] Raphen Becker, Kevin McLaughlin, and Samuel A. Rebelsky. Project Clio: Tools for tracking student use of course webs. In Proc. of ED-MEDIA 99, pp. 981-986.

[11] C.K. Chang, G.D. Chen, and Kou-Liang Ou. Student Portfolio Analysis by Data Cube Technology for Decision Support of Web-Based Classroom Teacher. Journal of Educational Computing Research, Vol 19(3), 307-328, 1998.

[12] Rakesh Agrawal, Heikki Mannila, Ramakrishnan Srikant, Hannu Toivonen, A. Inkeri Verkamo: Fast Discovery of Association Rules. Advances in Knowledge Discovery and Data Mining, pp. 307-328, 1996.

[13] Rakesh Agrawal and Ramakrishnan Strkant, Mining Sequential Patterns. ICDE, pp. 3-14, 1995.

A study of collaborative teaching for creative learning in an engineering class

Jiunn-Chi Wu[*], **Pei-Fen Chang**[**], **Shu-San Hsiau**[***] **and Tse-Liang Yeh**[****]
Dept. of Mechanical Eng., National Central University, Chung-Li, Taiwan
[*]*Tel: +886-3-4267335, junwu@cc.ncu.edu.tw*
[***]*Tel: +886-3-4267341, sshsiau@cc.ncu.edu.tw*
[****]*Tel: +886-3-4267339, tlyeh@cc.ncu.edu.tw*
[**]*Center for Teacher Education Program, National Central University, Chung-Li, Taiwan*
[**]*Tel: +886-3-4227151~3853, pfchang@cc.ncu.edu.tw*

We synthesize a model for cultivating creativity that integrate the tasks of engineering design, and evolves four cognitive processes of creativity knowledge and skill via web courseware. This paper discusses three main themes of creative learning: 1) the effectiveness of collaborative teaching and course modules, 2) tools for fostering creative learning, and 3) interaction on the web-environment via creativity contest and design project. Several findings were observed based on qualitative evaluation of this class. First, the most rewarding course topics identified by the students is the creativity contest and design project because it provides ample opportunities to solve real-life open-ended problems, rather than to deal with dichotomous textbook problems. However, adapting dissimilar teaching style of our collaborative teaching generated anxiety to a number of students, which suggest the structure and sequence of the course development are need to be modified in order to fit students' level of capacity and readiness. Finally, we have demonstrated how problem solving and engineering design procedures can be closely integrated and taught, and what are the necessary knowledge and skills to enhance students' ability to become creative as well as effective problem solvers.

Keywords: **Collaborative teaching, Creative learning, Web-based learning**

1 Introduction

Creativity is inherent and a native intelligence. Many studies, show that the creative cognition can be trained and learned [1, 2]. Therefore, proper education and nourishing environment can foster creativity. *Creative problem solving* (CPS) is referring to use creativity or creative thinking for problem solving, which is a learning model being actively studied [3, 4]. It helps student use systematic method to solve a complex and realistic problem, possibly with multiple solutions. Students brainstorm to generate all possible solutions, categorize and evaluate solutions, develop implementation plan, and finally execute the plan [3]. CPS emphasizes the practice of creative thinking, implementation of creativity, and stresses on the creative leaning process. It can be regarded as a learning model for knowledge synthesis.

It is our responsibility and challenge as teachers to educate student who will be able to succeed in the high-tech environment. To educate students to cope with the rapidly changing world, they must not only to actively acquiring new knowledge, but also to have the skill of creative problem solving. In reflecting such responsibility and challenge, the course of "*Open-ended Creative Mechanical Engineering Design*" was offered in Department of Mechanical Engineering, National Central University for the last three years. The spirit of this course is asking students use their creativity to work as industrial engineers, form several mission-oriented teams, communicate and cooperate with other people, and deal with real industrial open-ended problems.

We wish to demonstrate how problem solving and engineering design procedures can be closely integrated and taught and what are the necessary knowledge and skills to enhance students' ability to become creative as well as effective problem solvers. Hence, we synthesize a model for cultivating creativity that integrate the tasks of engineering design, and evolves four cognitive processes of CPS knowledge and skill via web-based courseware. An integrated web-courseware [5] is constructed for above purposes. In the following sections, four main themes in our study will be introduced: 1) the collaborative teaching and course modules, 2) tools for fostering creative learning, and 3) interaction on the web-environment via contest and design project.

2 Collaborative teaching and course modules

2.1 Collaborative teaching

Based on the experiences for the past three years, we perceive the need for professionals from other disciplines to stress the importance of communication as well as teamwork skills for engineering students. More importantly, a scientific evaluation of the course and its effects on the students' learning of creativity must be done in cooperating pedagogical experts with engineering ones. The analysis of student outcomes can give information about the success of the innovative course in achieving our objectives.

But the question is: how can professors with engineering background to integrate their technical knowledge with an educational-oriented perspective? Engineering faculties may understand the cognitive and emotional conflict that students encounter, but couldn't verify their teaching approaches in order to take into account students' different learning styles. Besides, an engineering course taught by faculty of non-engineering background face a challenge of given students the new perspectives without accommodating the technology orientation of engineering students.

With above forethought, we propose and implement the collaborative teaching from four professors of interdisciplinary backgrounds: thermal/fluid sciences, mechatronics, education, and network-based learning. Collaborative teaching is a novel teaching approach, it allow teacher deliver lecture in a more efficient way and share mutual teaching experience, improve teaching deficiency, and understand learning difficulty of students. In devising the design-oriented courseware, besides compose the materials for hands-on creativity project, we also strengthen educational idea of cognitive psychology, learning strategy and learning evaluation. Such collaborative teaching team up with the expertise of education and engineering is hoping to build a nourishing environment for rising student's learning motivation, encouraging student to develop mature, diversified cognition and thinking, and then be able to perform higher level of creative thinking.

2.2 Course modules

The contents and modules (see Table 1) are designed to develop competence in mechanical engineering, creativity, and teamwork. Five major units are emphasized: 1) Introduction of creativity, 2) Basic principles of CPS process, 3) Hands-on learning activities to inspire creativity, 4) Engineering design process, 5) Creativity contest and design project. In the first one-third activities is centred on the development and inspiration of creativity and creativity education, and the next one-third of the units enable students to practice the creative mechanical engineering design. The last one-third of the activities finishes the implementation of creativity phase so as to show off student's imagination with the creativity contest and design project.

We use creativity contest and design project as a tool to enhance creative learning of students. One creativity contest is hold in every semester in order to incubate students' learning interest. It is all up to students to decide the material, procedures, requirements, and rules for the creativity contest with teacher's facilitation in order to develop the environment of freedom.

The design project could relate basic principles and concepts to real problems and to improve students' understanding, motivation and creativity [6]. Implementing a project is a way to encourage students to look deeply and laterally at individual topics and consider how they can be applied to real situation. They motivate students to confront both familiar and unfamiliar situations with confidence, providing a sense of achievement and satisfaction. Each team member is expected to be aware of the specific skills of others in order to achieve effective and collaborative working relationships. More importantly, each member needs to take other people's views into account.

3 Tools for fostering creative learning

We construct three tools to assist the creative learning process: 1) the creative activity board, 2) the search engine, 3) the engineering courseware of domain knowledge.

The creative activity board, which is a web-BBS, is employed as the main interface for creative activity. Students are encouraged to actively utilize their own web-BBS for discussing their design projects with teachers and with classmates. They can announce important messages (e.g., resource acquiring) and post their current executing status of their project. More importantly, this board can be used to share their ideas and problem-solving approaches at any times with anyone who is interested in the topic. For convenient discussion of the creative ideas via network, particularly in the format hand-made sketches or the design charts, a FTP (download/upload) function is added in this board. Every user can participate the creative activity through web. The evolution and implementation of creativity can be recorded and exhibited. Properly application of this board can encourage students' morale for continually performing their design projects.

Students may encounter many problems when they execute the design project. The related information may be found in the courseware of domain knowledge or discussed in the creative activity board. Through the search engine, students can find useful knowledge and retrieve information from the integrated courseware more effectively by using appropriate keywords.

The creative activity cannot be successful without domain knowledge as its foundation [7]. When students are working on their team design projects, they need to integrate their domain knowledge based on the previous courses. There are four course modules materials are integrated: 1) Machine Design Course, 2) Electric Circuits and Electronics with Laboratory, 3) Innovative Application of Engineering Software, 4) Creative Mechanical Design. See [8] for detail description of content of these course modules.

4 Results: interaction on the web-environment

In the beginning whether students invest themselves in the class or not, depends on the development of the feedback from teachers. We use the web-BBS as the interaction interface with the students. After each team reported their project status, we will comment their idea and improvement of design prototype. Next, their status report will be upload in the creative activity board, and allow peers to review and comment. Encourage and endorsement from peers and teachers goes to those active teams. All interactions on the web are transparent and will inspire student if teachers can give feedback just-in-time, and guide each team to post their suggestion. In this way, both students and teachers will not be trapped in the classroom, and once the obstacle is encountered, it can be posted in the web and then exchange message. The more people to view these obstacles, the more possibility for the problem can be solved. Since not only teachers can help, peers can assist too. This is what we observed in this class when student performing their design projects. Positively and timely feedback from teacher and classmates enrich the value of the board.

We made surveys based on interviews, questionnaires, and articles of creative activity board. The most rewarding course content identified by the students is the creativity contest and design project because they provide ample opportunities to solve real-life open-ended problems, rather than to deal with dichotomous textbook problems. However, others are disturbed by the open-ended nature of the course materials. They claim that it is tiresome to cope with various teaching styles of four individual teachers. The evidence from our research also suggests that students' problem solving processes were affected by their understanding of the rationale of interdisciplinary course development. Therefore, teachers need to assist students to make their own links with the material they are engaging with in order to eliminate the negative impacts of the course content. For instance, increase the teaching topics involving mechanical hands-on activities might provide students more practice and appreciate the CPS process.

The issues of students' learning difficulties are complex and dependent on several factors, including course organization and development, the subject or topic being taught, teaching style, and students' expectations [9]. Although students see the new learning experience as an opportunity to broaden their scope, some others claim that the challenge of finding a design topic themselves was beyond their ability to manage. In order to set the stage for project design, our data showed that it is crucial that team members to accommodate each other and to devote their personal commitment. It is clear from our interview that failure to do so did influence the students' motivation to finish the project.

5 Conclusions

We have created a learning environment that facilitates students' development of problem solving abilities, enhances their confidence for cooperative creativity, and finally, provides students knowledge and skills for mechanical engineering design. The collaborative teaching is a novel experience to both of teacher and our student. Each member contributes their expertise and become the tutor to the other members. More importantly, the effort of compromising one another on the process serves as a role model for their students to work cooperatively.

The results of this study suggested significant concern for the students' anxiety created by the need to meet the special requirements of four individual teachers. It leads us to speculate whether the structure and sequence of the course development are appropriate to the students' level of capacities and readiness. Rather than viewing these problems as collection of obstacles and difficulties, we believe that we can make a difference in the learning of our students and chose to conceptualize those dilemmas and challenges in a constructive guide. Hence, we are currently adopting a new teaching approach by dividing the class into expert versus observer groups. The emphasis of the approach is to take responsibility as a learner and to develop the ability to ask questions about the projects done by other groups. We also conduct a peer-evaluation to encourage student to evaluate each other' s projects critically and objectively. We wish students to believe, as we did, that creative learning is within reach of anyone who is willing to exert himself and take responsibility.

Acknowledgement

This research work is supported by the Ministry of Education of the Republic of China in Taiwan under grant: Grand Project for Excellence, 89-H-FA07-1-4.

References

[1] Bransford, J. D. and Stein, B. S., *The ideal problem solver: A guide for improving thinking, learning, and creativity* (2nd ed.), New York: W. H. Freeman and Company (1993).
[2] Chance, P., *Thinking in the classroom: A survey of programs,* New York: Teachers College Press (1986).
[3] Sternberg, R. J., & Lubart, T. I., *Defying the crowd: Cultivating creativity in a culture of conformity*, New York: Free Press (1995).
[4] Lumbsdaine, E.& Lumbsdaine, M., *Creative Problem Solving*, McGraw-Hill (1995).
[5] CEdesign, http://lisant.src.ncu.edu.tw/cedesign/ (in Chinese).
[6] Blicblau, A. S. and Steiner, J. M., "Fostering creativity through engineering projects," European Journal of Engineering Education, vol. 23, pp. 55-65 (1998).
[7] Jonassen, D. H., "Instructional design models for well-structured and ill- structured problem solving learning outcomes," Educational Technology Research & Development, vol. 45, pp. 45-94 (1997).
[8] Hsiau, S. S., Wu, J. C., Yeh, T. L. and Tsai, S J., "The web-based learning environment for creative design course," Proceeding of 2000 Internatinal Conference on Engineering Education, Taipei, Taiwan, Aug .(2000).
[9] Pirrie, A., Hamilton, S. and Wilson, A., "Multidisciplinary education: some issues and concerns," Educational Research, vol. 41, pp. 301-314 (1999).

Content Outline	**Learning Activities**
Orientation to creativity	1. Introduce the importance of creativity to learning
Cognitive process of creative problem solving	2. Illustrate four stages of CPS skills
Thinking styles and contexts for developing creativity	3. Demonstrate pros and cons of various thinking style
Creative personality and teamwork experience	4. Film-viewing to illustrate the characteristics of creative people 5. Interview team members and identify their personality

Principles and strategies of lateral thinking	6. Analogy 7. Simulation activities
Conventional engineering design process	8. Discuss basic rules for invention 9. Apply rules to improve the design of commercial product 10. Brainstorm potential ideas for creativity contest via web
Problem solving in electric circuits and electronics (E&E)	11. Problem solving a case to illustrate the E&E concepts relate to project design
The creativity contest (by individual)	12. Peer-evaluate and select the top three most creative rubberband-powered vehicles
Research for proposal (RFP) of creative design project (by group)	13. Develop a RFP based on all information gathered 14. Oral presentation to class

Table 1 The course modules of the *CEdesign* web-class.

A Study of Networked Constructive CAI System Using Multiplication-Concept of "Transformation of Unity Quantity" on Elementary School

Pou-Yah Wu*, Shu-Fen Tsai, Yao-Quan Li, Jian-Zhi Lin, Jun-Rong Chen, and Xiang -Ting Huang
Department of Mathematics Education, National Tainan Teachers' College
33, Sec. 2, Su-Lin Street, Tainan, Taiwan 700
**Pou-Yah Wu's email:pywu@ipx.ntntc.edu.tw*

The feature of networked constructive CAI system lies in shaping the computer environment in which students clarify and construct the concept by ways of communication, discussion, and dialectics, utilizing the practical pedagogic content edited by the spirit of new curriculum in Taiwan at 1993. Because we stress the concept of "transformation of unity quantity" as main activity in teaching multiplication, students' comprehension of "unity quantity", "unity number", and "combined numbers" plays an important role in establishing networked constructive CAI system. We consider that the greatest difference between the networked learning environment and that of the general classroom pedagogy is the deficiency of interaction. Thus, analyzing the strategy of students' solving problems to establish the effective tool table of operation and judging the mode of the students' thought by checking the tools which students use will strengthen the interactive relationship of the system and the learners. Then, use the networked technology and the principle of the expert system to set up the CAI of constructive pedagogy, so that the learners can communicate with each other and the system can conduct dynamically which formally construct a wholly co-operative learning environment and will help the learners to form the whole mathematics concepts.

Keywords: **Constructive pedagogy, Elementary School, Multiplication of Mathematics, Networked CAI.**

1 Introdution

The characteristic of implementing new curriculum of mathematics at elementary schools in Taiwan now lies in the addition of spirit of constructivism, aiming at expecting students to construct knowledge positively. Thus, the teachers' role, in the process of pedagogy in new curriculums, changes into "problem poser", whereas students' learning activities in class attain socialized mutual sense, chiefly by communication, construct their own mathematical knowledge by way of mutual dialectics [5,6]. However, it takes pedagogy of construction longer than traditional pedagogy. The atmosphere and skill as to how the teacher directs students to construct knowledge and how the students discuss influence the effect of implementing new curriculum. In the light of the fact the trend of the times facilitates pedagogy of network to become widespread, the future construction of leased network lets us expect the popularity of "learning at home" and "long distance pedagogy". Therefore, the possibility of displaying a really approximate leaning setting of constructing pedagogy in the network environment becomes much higher. The establishment of the network system of pedagogy of construction, owing to the trend of current situation, is becoming imminent.

The aim of this study consists in designing a learning environment of network suitable for "multiplication concept in elementary school" . The greatest difference between the learning environment of network and that of the general classroom is the deficiency of mutual response [22,26]. And the pedagogy of construction hopes the communication and dialectics to bring about reflection, inspiring students to construct mathematics self-concept. Therefore, how to promote the mutual relationships between the system and the user is one of the considered points about constructing system in this study. Furthermore, how to develop the characteristic of pedagogy of construction in the system and how to make the pedagogic contents of the new curriculum manifested in the system wholly and fluently is the second chief point taken into account. Aimed at the above two points, that we use network technology, letting the real-time communication proceeded between the learners, or between the learning and system make up a wholly cooperative learning environment. Furthermore, making use of the principles of the expert system to deal with the learning strategy of the problem solver, through the concepts manifested by the problem solver, the system will feedback suitably, and will communicate with the students properly, which can make the pedagogic activity proceed dynamically [19,25]. The design of the pedagogic content, expect considering the sprit of the new curriculums, the students' learning state, after the teachers' real pedagogy, is mainly considered about designing pedagogy. Hence, this system is much closer to the real situation of pedagogy them CAI sold in the market. And the activities of problem solving given to the learner by system would be more congenial to the learner's mode of thought.

2 Principles of system constructing

2.1 Base of learning theory

"Knowledge is positively constructed by the learner rather than being inculcated passively from outside," which is the fundamental proposition of constructing pedagogic paradigm. The students, with acquired knowledge, enter another stage as an active subject of recognition, with good theory by themselves, instead of ignorance and irrationality [16]. But pedagogy of construction does not mean the teacher's role is unnecessary. On the contrary, we realize the aim of pedagogy is to make children construct the activity types of solving problems. In the light of this, the teachers' role becomes "problem poser" rather than "problem solver" in the process of pedagogy. By way of the teachers' posing problems, children undertake the activity of solving problems by themselves; or children become "imitators" through the activity of solving problem provided by the teacher [4]. By these processes, students are provided sufficient experience of solving problems, and then construct the correct mathematics conceptions. Besides, what we must also pay attention to is the teacher and the learner grasp the intentions of each other aiming at the proceeding actives of each other, through trial and dialectics, until both of them relieve the pressure aroused by the interchange actives. The relief of pressure is limited by the fact if the problem is solved according to the activity, and is also influenced by the affectionate expression of them both present of them both present [24]. Therefore, in pedagogy of construction, socialized communication is an important feature [3].

2.2 Base of system establishing

This system is a learning environment constructed in the network, adopting three-tier client/server system architecture: that is, adding another service server on the original framework of the two-tier client/server system in this three-tier client/server system architecture, the management of Database Server charges learning data. Web Server is responsible for teaching, whereas the user of Client precedes all kinds of learning activities ivies through browser machine.

3 Pedagogic design of Multiplication using transformation of unity quantity

3.1 Concept of multiplication

Multiplication referred to by Davydov (1991) is the problem of transformation of unity quantity, that is, the transformation from composite unit to that of the single item [20]. And Clark and Kamii (1997) think that if children own the multiplicative thinking, they will simultaneously deal with lower level unit such as unit of one and the higher level unit different from unit of one [18]. Tzyh-Chiang Ning (1994) mentions that the so-called multiplication operation contains at least two kinds of relationship: (1)the coordinating relationship of two levels,(2)the part-whole relationship of two levels. The problem of multiplication is in reality that of the transformation of unity quantity, namely, the problem of transforming quantity from higher level unit to lower level unit [7,8,9].

3.2 Pedagogic design of multiplication using transformation of unity quantity

The recognition of new curriculums toward mathematics concepts specifies the activity types of solving problems of interiorization [17,23,26]. And he origin of mathematics knowledge embodies the activity of solving problems, instead of tangible objects [5]. Thus, the ideas of new curriculum do not emphasize the existence of calculating problems. The generation of all forms of calculation is entirely for the need of the practical contexts; also the measurement serves as the source of multiplication in the practical contexts [20]. Hence, the appearance of new curriculums in pedagogic content lets students have the necessary sense of owing multiplicative thinking rather than multiplication directed by "multiplication table" of old curriculums; whereas "transformation of unity quantity" is the pivotal point in designing teaching material of new curriculums, different from the viewpoints that look upon multiplication as "repeated addition" [21] in the design of multiplication of old curriculums. In other words, students' comprehending "unity quantity", "unity number" and "combined numbers" in the process of solving problems plays an important role in the design of material content of new curriculums. Tzyh-Chiang Ning (1993) [8]mentions that there are three classification of difficulty in the management of initiatory material of multiplication in new curriculums:(1)the students can tackle the problem of transformation of unity quantity (2)the students can solve and record the process of solving problems concerning about transformation of unity quantity,(3)the students can describe the record of the problem of transformation of unity quantity by multiplication sign. Therefore, in the design of pedagogy of multiplication, the arrangement of new curriculums lies in the fact the teacher set up a problem of multiplication in the practical contexts, and the students handle and record the problem by themselves after conveying the message of the problem. The students' knowledge is chiefly constructing from the consultation, inquiry and dialectic between the teacher and the peers; via the established learning by the concept of constructive pedagogy, the teacher should, in the process and record of the students' solving problems, help the students clarify the existence of "unity quantity", "unity number", and "combined numbers" in the problems. The students should also attain the unanimous compromise of the format of record; that is, the format of the students should wholly suggest "unity number ", "unity number", and "combined numbers". When the process of pedagogy arrives here, students have at least finished the level of the second difficulty mentioned by Tzyh-Chiang Ning. As to the application of multiplication sign, it is the flowing and economic problem of culture and communication. New curriculums, thus, undertake such a linguistic transformation of "a×b=>a lots of b=>b multiplied by a." and then bring multiplication sign serving as the operator of recording format. If the students can make use of multiplication symbol as the operator in the recording format, we may well say that they attain the level of the third difficulty. While the students reach that level, they are equipped with initiatory concept of multiplication; in other words, arrive at the formation of " multiplication" concept gradually through "experience"," perception" and "realization" [4].

4 Simulation of the process in the constructive pedagogy

Since our CAI system stresses the spirit of the constructive pedagogy, we hope that the whole computer environment would become more compatible with the real environment of pedagogy. What we must emphasize is the teacher himself/herself is the most important natural resource in the environment of pedagogy. All our set CAI would attain is how to let the computer simulate the mode of thought in the teachers' real lecturing, even to let the computer "realize" the mode of the students' thought. With a view to achieving such an effect, we design operation tools for users' use. We can discriminate the stages of students' thought by the users' choosing tools, which will let the computer analyze the students' mathematics competence through the stage of the students' operation, and simultaneously let the computer carry on dialectics, clarification and discussion by simulating the role of the teacher or that of the student. We can achieve a process of socialization on the computer by such a process of the design. And via such a process, the user can "experience"," observe", and "realize" the concept of multiplication, and finish three tasks of the stages: (1) the students can tackle the problem of transformation of unity quantity (2) the students can solve and record the process of solving problems concerning about transformation of unity quantity,(3)the students can describe the record of the problem of transformation of unity quantity by multiplication sign. Take Figure 1 as an example, students can move the bone to the bay by the mouse, then the computer system may judge whether does he/she understand the meaning of problem. We hope to make students gain more self-affirmation by manipulating. As show in Figure 2, our system provides the electric board and the tool table. User can simulate the situation in the class to solve the problem and record the format. In additional, system also supports the different operation tools for users. And the system can provide different solving method to help users constructing their operation by judging what kind of tools they choose. The system also can judge users' operation mode by checking their record format, then, the system will master students' learning condition well, and teach dynamically. Besides, the system also provides virtual students to communicate with users as showing in Figure 3. It will increase the users' learning interest. Virtual students that design for guiding user and make the environment of discussion can provide proper help but not answers in fitting time.

5 Architecture and implementation of system

5.1 Environment of design and tool

This system uses Windows NT server as server. Developing languages include HTML, JavaScript, Active X, ASP (Active Server Page) and so on. ASP is used as the chief method of control, and ASP and ODBC (Open Database Connectivity) are exercised to match. The management of the teaching material's user becomes simplified. As to the edition of the curricular software, Authorware 5 is mainly used for developing tools.

5.2 Process of system

Process of the system we designs just as Figure 4 shows, the general elucidation is as follows,

1. Pedagogic situation of network construction

The system after the analysis of the pretest makes sure the sorts of the user's operation and then to pose problems according to the classification. The system will communicate and clarify the messages of the problems by the tools in tool table. After the sorts of tools by user to discriminate if he/she has grasped the messages of the problems, the system will provide tool table further, letting the user record by the tools. In this stage, along with level of the user's operation, the system will afford problems, via simulating the role of the student or the teacher to carry on the activities of dialects, clarification, and let the user reflect and modify his/her recording format to match the basic requirements of "unity quantity", "unity number" and "combined numbers" suggested in the recording format". Afterwards, adjust the next learning activity according to the learning state of the user until he/she can construct the concept of multiplication on the acquired basis and attain the learning level of the afore-specified third difficulty. Besides, the system can simulate the real learning environment on the network, letting the user's learning environment diverse.

2. 「Student model」 database

Student model consists mainly of three databases:

(1) Student basis database

It chiefly records the students' basis data such as name, age, the experience of using computers and so on.

(2) Database of learning.

It records the unit of teaching materials the student learned, the learning state of each unit and the duration of time, and the positive result of the students' learning.

(3) Database of learning achievement.

It records the students' assessment about answering and the stage of operation.

3. Database about "posing problems of constructive pedagogy"

The content of teaching material about constructive pedagogy include

(1) Phenomenal problem: this sort of problem can facilitate students to "experience" the mathematics concept.

(2) Psychological problem: this sort of problem can facilitate students to "observe" the mathematics concept.

(3) Sociological problem: this sort of problem can make students via discussion; attain the common sense of using recording, which would become the tool of communication.

(4) Anthropologic problem: this sort of problem can make the above – mentioned communicating tools and the correspondent expression in cultural become congenial.

4. Database of " problems"

This database is to store the problems for the pretest and the posttests.

5.3 Function of on-line communication

The system would establish a learning environment more congenial to real teaching situation thus the convenience for the user and for other users on the line to communicate, thereby setting up a network environment for undertake cooperative learning. The system designs a series of functions for on-line communication on the line, illustrated as the followings.

(1) Group of discussion

Group of discussion is an open but not synchronized function on the line. When the user encounters the difficulty in learning, he/she put up his/her questions in the group of discussion, letting other users put forth solutions to these questions.

(2) Room for discussion

As showing in Figure 5, the function of the room for discussion can improve the disadvantages of the personal computer learning CIA's failure to carry on communication, real-time discussion to a large extent, for it is an open and synchronous for communication. Besides calling the virtual teacher or student, the user can enter the room for discussion for help when he/she needs others' help to solve the questions.

(3) On-line Call

On-line call may be inputted simple information to communicate with other on-line users.

5.4 The operating process for the user on the system

When the user enters the system with the browser for the first time, the system will ask he/she to register as showing in Figure 6, thereby acquiring the basic data to establish the Database for "student model", and simultaneously letting the user accept pretest to discriminate the levels of the user's operation, and recording the situation of their answering, and the connection of active modification letting the user join the curricula suitably.

Afterwards, whenever the user enters the system, he/she must key in user name and password to make sure the identification. The system will continue the following activities according to the previous record of the user. The system would record each learning activity the user undertakes one by one, with the view of analyzing the fact if the learning state of the user will attain the expected aim. When the user encounters the line provided by the system: he/she can also check his/her learning state at any moment to grasp the learning progress.

6 Conclusions

The age of computer is that of knowledge explosion indeed. Undoubtedly, "Self-learning" is the best way to enrich self in the age of widespread information. With network becoming so widespread, it is not uncommon for the students of the elementary school to enter the network. It is incumbent on us to let the teaching environment of CAI congenial to the concepts of teaching nowadays. We hope our CAI system will become compatible with the social need now, breaking through the limitation of time and space and overcoming the barriers of learning environment now, giving the learner more space to exert himself/herself. At present, this system has finished the prototype, and plans to precede real teaching experiments and systematic assessment in a few months.

Reference

[1]周筱亭, "數學新課程的趨勢", 研習資訊, Vol. 11, No. 3, pp. 28-50, (1994).

[2]侯志欽, "教學設計的哲學省思—由客觀主義到建構構主義", 國民教育集刊, Vol. 17, pp. 221-229, (1999).

[3]甯自強, "「根本建構主義」—認知研究的另一種架構", 師友月刊, 12 月號, pp. 30-32, (1987).

[4]甯自強, "經驗・察覺・及了解在課程中的意義—由根本建構主義的觀點來看", 論文發表於國立台東師範學院八十一學年度國小理科教育學術研討會, pp. 191-197, (1992).

[5]甯自強, "國小數學科新課程的精神及改革動向—由建構主義的觀點來看", 科學教育學刊, Vol. 1 No. 1, pp. 101-108, (1993).

[6]甯自強, "「建構式教學法」之教學觀—由根本建構主義的觀點來看", 國教學報,Vol. 5, pp. 33-41, (1993).

[7]甯自強, "單位量的轉換（一）正整數乘除法運思的啓蒙",教師之友, Vol. 34, No. 1, pp. 27-34, (1993).

[8]甯自強, "新課程對乘法啓蒙教材的處理", 論文發表於國立嘉義師範學院八十二學年度數學教育研討會, 四月二十九日, (1994).

[9]甯自強, "單位量的變換（二）—正整數乘除運思的融合", 教師之友, Vol. 36, No.5, pp. 35-44, (1995).

[10]甯自強, "數學的格式與內容—皮亞傑對維高斯基", 論文發表於台北市立師範學院「皮亞傑及維高斯基的對話」百年校慶學術研討會, 元月二十五・六日, (1996).

[11]甯自強, "劉裕誠的數概念", 1997 海峽兩岸幼兒教育學術研討會論文集, pp. 167-185, (1997).

[12]甯自強, "涂景翰的數概念", 科學教育學刊, Vol. 6, No. 3, pp. 255-269, (1998).

[13]甯自強, "顏淑茹的數概念", 國教育研究學報, Vol. 4, pp. 231-264, (1998).

[14]羅清水, "認知心理學理論對電腦輔助教學設計發展與成效之影響", 研習資訊, Vol. 15, No. 1, pp. 1-15, (1998).

[15]鍾靜, "從疑難問題談乘法文字題教學", 國教月刊, Vol. 36, No. 9,10, pp. 33-35, (1980).

[16]蘇育任, "建構主義式的教育的迷思與省思", 國民教育集刊, Vol. 5, pp. 121-139, (1997).

[17] Bridgaman, P. W.," The way things are", New Your: Viking Compass, pp. 83, (1959).

[18] Clark, F. B. & Kamii, C., " Identification of multiplicative thinking in children in grades 1-5", "Journal of Research in Mathematics Education", Vol. 27, No. 1, pp. 41-51, (1996).

[19] Dalgarno, B., "Constructivist Computer Assisted Learning: Theory and Techniques", http://services.Canberra.edu.au/~barney/articles/ascilite96/paper.htm (accessed on Oct. 21, 1997).

[20] Davydov, V. V., "A psychological analysis of the operation of multiplication", In L. P. Steff (Eds.), Psychological abilities of primary school children in learning mathematics, Soviet Studies in Mathematics Education Series, volume 6, pp. 9-85, (J. Teller trans.) Reston, VA: NCTM. (1991)

[21] Fischbein, E., Deri, M., Nello, M. S., & Marino, M. S., "The role of implicit models in solving verbal problems in multiplication and division", Journal of Research in Mathematics Education", No. 16, pp. 3-17, (1985).

[22] Hiltz, S. R., " Teaching in a Virtual Classroom", http://it.njit.edu/njIT/Department/CCC/VC/Papera/Teaching.html (accessed 1995).

[23] Piaget, J., "The Psychogenesis of knowledge and its epistemological significance", In M. Piatelli-Palmarini (Eds.), Language and learning: The debate between Jean Piaget and Noam Chomsky, Cambridge, MA:Harvard University Press, (1980).

[24] Steff, L. P. & Wood, T. (Eds.), " Transforming Children's Mathematics Education: International Perspectives", Hilsdale, NJ:LEA, (1990).

[25] Squires, D., "Can multimedia support constructivist learning?" http://www.spirit.net.au/ACEC96/papers/squir.htm (accessed on Oct. 21, 1997).

[26] Van Engen, H., "An analysis of meaning in arithmetic I & II", The elementary School Journal, pp. 321-329 & 395-400, (1949).

[27] Webb, G., " A Theoretical Framework for Internet-Based Training at Sydney Institute of Technology", http://ausweb.scu.edu.au/proceedings/webb/paper.html (accessed on July 5-9, 1997).

Figure 1:The clarification of the problem

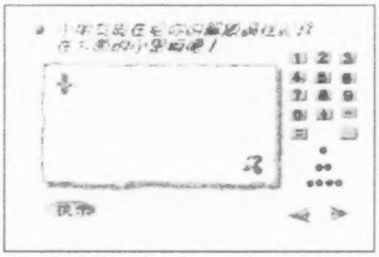


Figure 2: The electric board and tool table

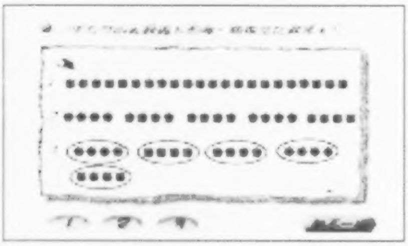


Figure 3:The strategies of virtual students

Figure 5:Room for discussion

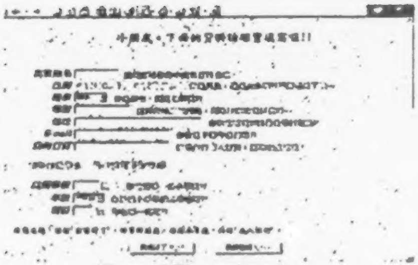


Figure 6:The registration

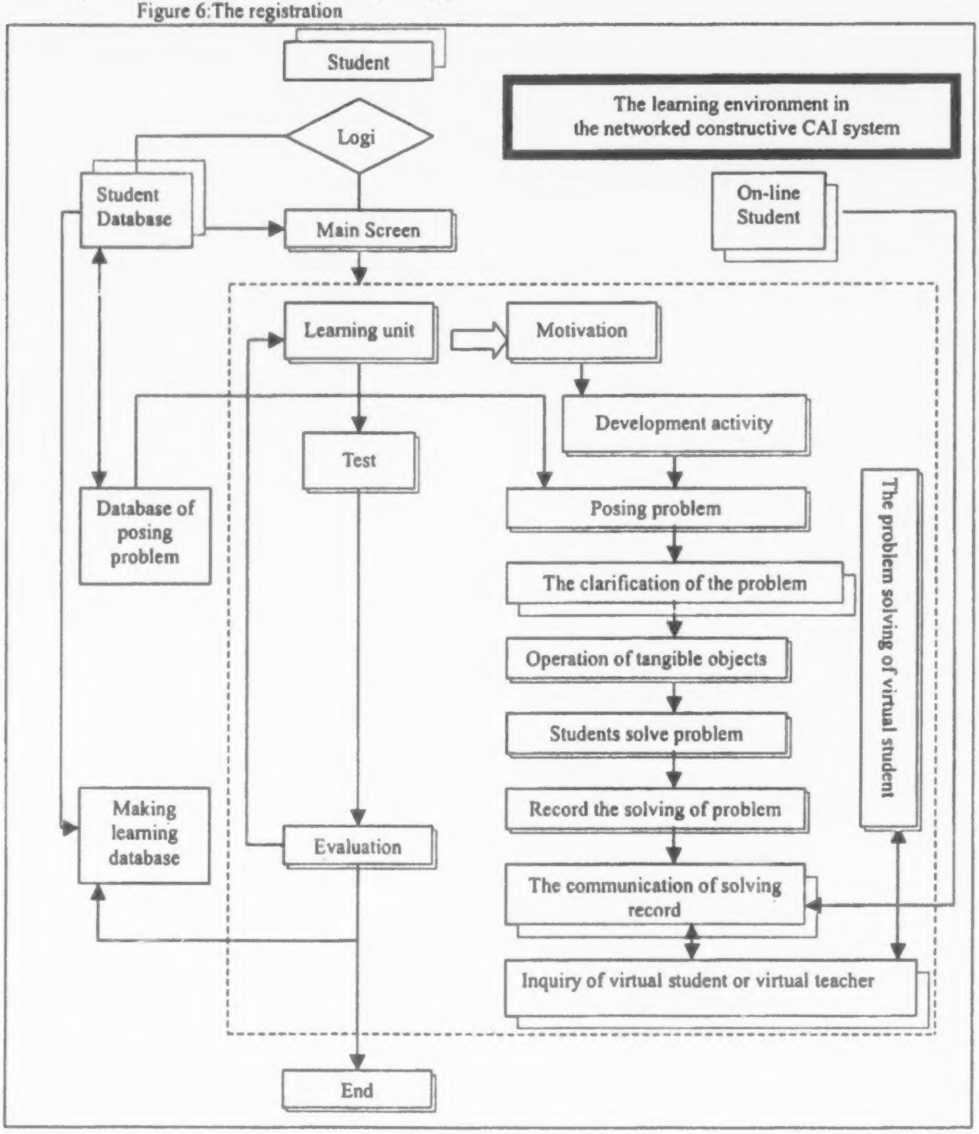

Student
The learning environment in the networked constructive CAI system
Logi
Student Database
Main Screen
On-line Student
Learning unit
Motivation
Development activity
Test
Database of posing problem
Posing problem
The clarification of the problem
Operation of tangible objects
Students solve problem
Record the solving of problem
The problem solving of virtual student
Making learning database
Evaluation
The communication of solving record
Inquiry of virtual student or virtual teacher
End

Figure 4:   System flowchart

A Study on the Effectiveness of Web-based Collaborative Learning System on School Mathematics :Through a Practice of Three Junior High Schools

Masahiro NAGAI*, Yasuyuki OKABE, Jyunichiro NAGATA*** and Kanji AKAHORI***
**Tokyo Institute of Technology, Graduate School of Decision Science and Technology, Dept. of Human System Science 2-12-1,O-okayama,Meguroku-ku,Tokyo,152-8552,Japan*
Tel.+81-3-5734-3233 nagai@math.e.chiba-u.ac.jp, akahori@ak.cradle.titech.ac.jp
***Sumiyoshi School Attached to Department of Human Development,Kobe University*
5-11-1,Sumiyoshiyamate,Higashinada-ku,Kobe,658-0063,Japan Tel.+81-78-811-0232
yokabe@kobe-u.ac.jp
****Junior High School attached to Department of Education,Chiba University*
1-33,Yayoicyo,Inage-ku,Chiba,263,Japan Tel.+81-43-290-2493 nagata@jr.chiba-u.ac.jp

The topic of Internet for educational purposes is currently hotly pursued but there are still not many observations on the effectiveness of it in school mathematics. In this paper, we discuss the findings of Web-based collaborative learning in school mathematics conducted with three junior high school in Japan, March 2000. Students performed asynchronous collaborative learning using bulletin-board type database installed in a Web server set at the Koshikawa laboratory in Chiba University. Students solved several mathematical problems presented on a Web page while discussing with other students in the database. In classes using the Internet, 3 or more methods of the problem solving emerged in the database as compared with a traditional class, and students could study many mathematical views and conceptions as a result of it. Moreover, a research of the student's opinions after the lessons indicated that students wanted to hear the other students' ideas and views and have collaborative learning, breaking down the traditional concept of the classroom wall barrier.

Keywords: **Web, Bulletin Board, Collaboration, School Mathematics**

1 The background and intention of this research

It is now believed that mathematical knowledge is created through collaborative learning, rather than something individual. This is based on social constructivism in recent years. And teachers have come to accept their new position of an advisor to the students as shown by Vygotsky's "Zone of proximal development".

Through using a distributed network such as the Internet, its very features are effectively utilized and allows the externalization of the student's knowledge. These knowledge can then be shared and this learning method is in accordance with the present idea of how learning occurs[4]. Thus, we have researched on web-based collaborative learning on school mathematics from 1998 focusing on this point[1][2]. With Web-based collaborative learning, it efficiently and effectively overcomes whatever physical differences the students may have and thus widely used for science and social studies lessons.

In mathematics, objectivity is the rule and therefore, there is no need for students to be able to express regional difference clearly and there are not many investigations into web-based collaborative learning of school mathematics. In this paper, we describe the qualities and reasons for conducting Internet based collaborative learning of school mathematics. We also describe the results of the questionnaire distributed to the students after the lesson.

2 The method of collaborative learning

In this research, we used the "bulletin board[1]" system that can be downloaded free from the Web site. As shown in Fig.1, the discussion progresses by entering in one's idea and posing questions to the others' idea or opinion. Students build their knowledge positively and share them in this process. The discussion is displayed by a tree structure whereby a reply to a question or comment is indicated with a new line, separated from the previous note with a slight space. Each new reply is so indicated, forming a tree structure. The symbol[2] is given to each utterance so that the kind of utterance may be understood. This database was installed in the Web server "Topo" at Koshikawa laboratory, Faculty of Education, Chiba University, and linked to the web page that we refer to as "The Page of Mathematics Teaching-Materials Research[3]". Students used this system for its school mathematicsFig.3. Fig.2 shows the notes which students have entered. Students study, choosing between the two screens, i.e. Fig.1 and Fig.2.

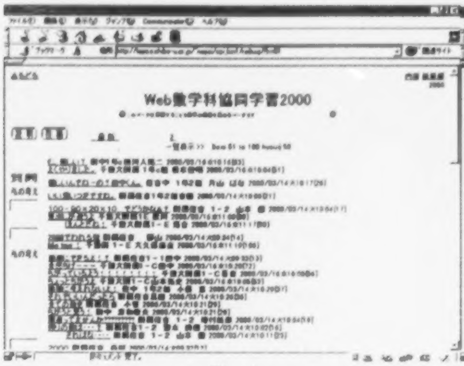


Fig. 1

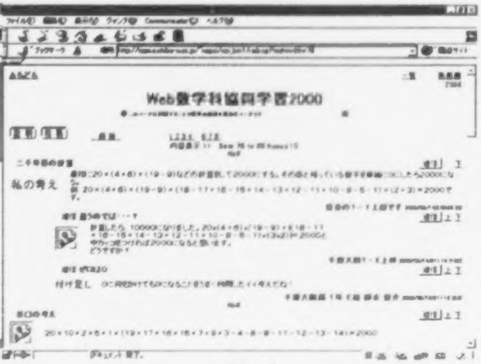


Fig. 2

3 The outline

The Web-based collaborative learning was performed as follows.

O Student participants

Nagaura Junior High School, 1st grade 2 class
Sumiyoshi Junior High School, 1st grade 3 class
Junior High School attached to Chiba University, 1st grade 3 class

O Term March 2000

O Instruction plan

Each junior high school had a 2 hours lesson.

The 1st hour ···Students read the problem and produce their own ideas. And, they enter in their questions and opinions.

The 2nd hour···Students read the others input and enter in their ideas. And they continue the discussion.

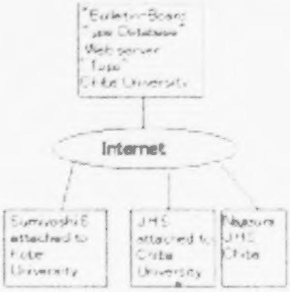


Fig. 3

3.1 Problems given to students

---

[1] raib-g 2.04 (wakatiai program)

[2] Question="質問"，My Theory="私　考　", etc.

[3] The author's page. http://www2.ak.cradle.titech.ac.jp/nagai/math_room/math.asp

The Grant-in-Aid for Educational Research, Chiba Prefecture(1997), and the Grant-in-Aid for Scientific Research, Japan Society for the Promotion of Science(Encouragement Research B, subject numbers 10913006,1998 and 11913005,1999) are granted to this page.

The two following problems were shown on the Web page at the beginning of the collaborative learning. Students solved the problem given to them with instructions from the teacher.

○Problem1
This year is A.D. 2000. Let's make the following formulas.
(1) The answer is set to 2000, using all the number of 1,2,3,4,~,19, and 20 at least once.
(2) Each number can be used only once.
(3) You may change the sequence of numbers.

○Problem 2
How to find, among a set of twelve balls, one which is lighter than any of the other equally-weighted eleven? You have only three chances to use a pair of balances. (Please also consider the reasons and enter it in.)

3.2 The student's activity

First, students read the given problem and create their questions and ideas about the problem. Next, they access the database and enter their notes. They read the others' writing, and if something attracts them, they will write a reply. The activity was performed over 2 hours and problem solving was carried out. A questionnaire shows that students participated in this collaborative learning positively. The teacher's role is only to support the computer operations of the students or problem solving when needed. In the beginning, although there were many students who took time in deciding what to enter or how to operate the database, they got used to it gradually.

4 Analysis and consideration of the collaborative learning

These were two problems and the students solved either one or the other collaboratively. Three junior high schools tackled the problem using the Web-based collaborative learning for 2 hours. Another class was asked to solve the problems not using the Web-based collaborative learning method i.e. traditional method. We describe the difference in the learning produced from the difference between these two methods of instruction. We also analyzed the results of the questionnaire.

4.1 Regarding problem 1

With problem 1, students find as many formula as they can whose answer is 2000 using all the integers from 1 to 20. In the collaborative learning using the Web, students invented 14 kinds of the following methods.

Formulas obtained from the collaboration using the Web (14 methods)

1. 20×10×5×2+(1+3-4)×(6+7+8+9+11+12+13+14+15+16+17+18+19)=2000
2. 20÷10×(19-9)×(18-8)×(17-7)×(16-6)÷(15-5)×(14-4)÷(13-3)×(12-2)÷(11-1)=2000
3. (1+19+2+18+3+17+4+16+5+15+6+14+7+13+8+12+9+11+20)×10=2000
4. (3+5+7+8+11+12+13+14+15+16+17+18+19)×(6-2-4)+20×10×(9+1)=2000
5. 10×20×5×2-(9+6)+(8+7)-15÷3+(1+4)-(11+19)+(12+18)-(13+17)+(14+16)=2000
6. (19-18+17-16+15-14+13-12+11-9+8-7+6-5+4-3+2-1)×10×20=2000
7. 20×10×(1+2+3+4)+(13-6-7)×(5+8+9+11+12+14+15+16+17+18+19)=2000
8. 20×10×5×2+(4-3-1)×(6+7+8+9+11+12+13+14+15+16+17+18+19)=2000
9. (1+3+7+9)÷2×(20+15+5)÷4×(6+14+12+8+11+19+13+17)÷10×(18-16)=2000
10. {10+(11-1)+(12-2)+(13-3)+(14-4)+(15-5)+(16-6)+(17-7)+(18-8)+(19-9)}×20=2000
11. {1+2+3+4+6+7+8+9+10+11+14+16+17+18+19-(5+12+13+15)}×20=2000
12. 20×10×2×5+1×(19+17+16+7+9+3+15-4-6-8-11-12-13-14-18)=2000
13. (1+2+3+4)×10×20+5+6+7-18+8+9-17+16+13-14-15=2000
14. {(11-1)+(12-2)+(13-3)+(14-4)+(15-5)-(16-6)-(17-7)-(18-8)-(19-9)}×10×20=2000

Next, in the traditional class, only four kinds of formulas appeared.

Formulas obtained by the ordinary class (4 methods)

3. (1+19+2+18+3+17+4+16+5+15+6+14+7+13+8+12+9+11+20)×10=2000

10. $\{10+(11-1)+(12-2)+(13-3)+(14-4)+(15-5)+(16-6)+(17-7)+(18-8)+(19-9)\}\times20=2000$
15. $(11-1)\times10\times20+12-2-4-6+8-3-5+16-7-9+14+15+19-13-17-18=2000$
16. $(2\times3+4+5+6+7+8+9+10-11+12+13+14+15-16+17-18+19)\times20\div1=2000$

4.2 Regarding problem 2

With problem 2, students find the lighter weight out of 12, using only a pair of balances and within 3 steps. The following four methods of solving the problem appeared in the collaborative learning using the Web. The notation shows how to divide the 12 weights first. For example, "4 4 4" means to divide the 12 weights into three groups containing four weights in each group first.

◇The first division found in the collaboration using the Web	◇The first division found in the traditional class
(6 6) (4 4 4)	(6 6) (4 4 4)
(3 3 3 3)(5 5 2)	(3 3 3 3) (5 5 2) (2 2 4 4)

As shown above, four kinds of methods appeared in the collaboration using the Web and five appeared in the traditional class.

4.3 Analysis and consideration of the data

In problem 2, the variety of methods for solving the problem did not differ much between the Web-based collaboration and the traditional class. However, in problem 1, the number of methods on collaborative learning using the Web was 3 or more times as compared with the traditional class(Exact Probability Test, $p<.05$). For mathematics problems with limited answers, there is not much difference seen between the two methods of instruction. On the contrary, for problems with many possible answer, students achieve better results when they can do the problem solving with the other students through the Web. We definitely believe that the students are able to solve problems by referring to the other student's notes. This can be seen from the student's interaction. For problem 1, five formulas generally represented as "$0\times m+2000$(m is an integer)" were produced in the collaborative learning using the Web. This is the formula not produced from the traditional class. We consider that the students become aware of this general formula by referring to the others formulas, and they utilize this general formula to solve the problem. Moreover, the students are also influenced by notes such as those below.

First, $20\times(4+6)\times(19-9)$ etc. is calculated, and it is made 2000. Then, it will be set to 2000 if the number which remains is set to 0. Example $20\times(4+6)\times(19-9)+(18-17+16-15+14-13+12-11+10-8-5-1)\times(2+3)=2000$.

2000/03/14 Tuesday 09:25 [9]

Although the formula of this student's example lacks a necessary "7", it is considered that the explanation which means 0xm+2000 was very helpful. This can be read also in the following response to the note " ".

This is a good idea. Every number which is multiplied with 0 is 0. 2000/03/16 Thursday 11:12 [93]

Such examples show that there were some students who didn't only enter their formula, but the strategy as well, and it became a support to other students.

As mentioned above, in collaborative learning using the Web, since the others idea remains on record and can always be referred to, students could utilize this and solve the problem. Problem 1 is asking for many possible formulas whose answers are 2000. That is, we claim that collaborative learning using the Web is effective especially with problems which demand exemplification. And students were able to access many mathematical views and conceptions. This appears also in the result of the questionnaire shown as "Many students' ideas can be known. 49 persons." and "Various methods and ideas which are easy to understand can be known. 36 persons.", and it turns out that the student's incentive and understanding can be improved. These educational effects are obtained by the realization of collaborative learning using the Web, and cannot be obtained in the class which is traditional. We emphasize that the effectiveness of the collaboration using the Internet on school mathematics is demonstrated.

5 Conclusion

In this paper, we referred to the educational effect and influence of the collaboration of three junior high schools using the Web. As we have shown, it has been indicated that students can utilize many mathematical knowledge and conceptions when we use the Web with due consideration given to the type of problems the teacher thinks can extract the most out of the students. This shows that collaborative learning using the Web is useful to train various views and ways of thinking currently emphasized by the Ministry of Education in Japan and National Council of Teachers of Mathematics(NCTM)[3],U.S.A. We emphasize that the database on the Web is effective as an environment where students can tackle open-ended problems in mathematics.Considerations for the future include the improvement of the student's computing skills, the improvement of the system with regards to numerical expressions and careful selection of the kinds of mathematical problems to be given to the students. After all, according to a questionnaire, since it is indicated that 70 percent or more of students are supporting collaborative learning using the Web from various reasons, we want to continue the research wholeheartedly from its educational perspective.

Acknowledgement

We express our sincere thanks to Miss. Cheong. Meng. Mei and the following institution for assistance.
A part of this research is selected as a supporting plan in the Voluntary-Plan of the 100-School Networking Project (Phase II,1998) and the School-Plan of the E square project (1999) of the Center for Educational Computing.

References

[1]Masahiro NAGAI and Hiroaki KOSHIKAWA . "A Development of Collaborative Learning on School Mathematics Using the Web I" The Mathematics Education Paper Publication Meeting 31, Japan Society of Mathematical Education. 1998 . pp.283-288

[2]Masahiro NAGAI, Yasuyuki OKABE, Junichiro NAGATA, Hiroaki KOSHIKAWA, Tadashi TAKAHASHI, Kanji AKAHORI . "A Design of the Environment Supporting Collaborative Learning on School Mathematics Using the Distribution Network" . The Plenary Session of TSG6(Distance Learning in Mathematics Education) ICME9 at Japan, August 2nd 2000.

[3]NCTM . "Curriculum and Evaluation Standards for School Mathematics" . 1989

[4]Yutaka SAEKI . "New Computer and Education" . Iwanami Pocketbook .1997

[5]Matthew B.Miles, A.Michael Huberman . "Qualitative Data Analysis" . SAGE Publications . 1994

A Survey Study on Corporate Trainers' Experiences, Attitudes and Perceptions towards Intranet-Based Training

Doris Lee
Assistant Professor, Program of Instructional Systems
Penn State Great Valley School of Graduate Professional Studies
30 East Swedesford Rd.,Malvern, PA 19355, USA
Tel: 610-648-3266
Fax: 610-889-1334
E-mail: YDL1@psu.edu

1 Introduction

The Internet is a vast cyberspace where the user can gather, disseminate, and exchange all types of information. The World Wide Web was conceived to allow the user to have a single, unified means to create and access information from anywhere on the Internet [1]. An intranet is an organization's internal networked computer system and is usually protected by a firewall, a form of security software that permits only authorized users to the system [2]. The World Wide Web software also runs on most intranets, providing the same functions as used on the Internet. However, information on an intranet is often organized and delivered around an organization's specific needs rather then randomly shared as on the Internet. An intranet, therefore, grants an organization easier, faster and more secure distribution of information.

The above reason accounts for the rapid growth of intranet-based training (IBT) in American corporations [3]. IBT is the use of intranet to provide employees with instruction for the acquisition of various types of knowledge and skills. Researchers including Cohen [4] and Leong [5] believe that IBTcan increase interaction and collaboration among employees and reduce training cost. However, no empirical data can be found to verify this belief. Besides, the value and effects of IBT have not been scientifically determined. The questions concerning what kind of perception and attitude that corporate trainers have towards IBT, and what kind of factors or obstacles involved in the design and delivery of IBT remain unanswered.

The purpose of this paper is to present a survey study that examined corporate trainers' perception and attitude towards IBT. This study used closed-ended attitudinal questionnaire to investigate the amount of trainers' IBT experiences and their attitudes towards it. This study also included an open-ended written questionnaire to analyze trainers' perceptions concerning the value as well as benefits of delivering training via intranet, the current status of using IBT in the participating trainers' companies, and the design and development issues of IBT.

2 The Results

Fifty-five professional trainers or training managers participated in the study. Their age ranged from 24 to 58. Most of them have about 5 to 6 years of experience in designing or conducting face-to-face training. The average experience of designing or conducting computer-based training is about 1.5 years. The majority of them only have about two to three months of experiences in either receiving or designing IBT.

2.1 Attitudes and Status

The results reveled a positive attitude towards the value and use of IBT among the participating trainers (The mean for the attitudinal questionnaire is 73. 95, with a possible highest ranking of 105.00). Most of them indicated that their companies just began to use IBT. For example, they stated,

" Currently my organization uses very little web-based training. I am lobbying to move more toward web-based training. We use quite a bit of CB/CD training. We also make available a product knowledge training piece on our intranet."

"My Training Department is just getting involved with web-based training. We' ve researched both the content and user interface strategies and are now ready to begin our first billable project. In the past, we' ve created browsable user guides but are now advancing to interactive sites."

"My company uses CBT for upper management. We are currently arguing for web-based training as we are now networked in 12 counties across Pennsylvania. If successful, web-based will be used throughout the year for required 24 hours of training per year, as well as other applicable internal policy mandates. Web-based will be used for front-line middle and upper management teaching regulations, soft skills, medical and psychiatric knowledge, and project management."

2.2 Value of IBT

Most of the trainers believe that WBI is very valuable to their organizations by indicating:

" WBT is extremely valuable to my organization for specific courses such as regulatory compliance and business-specific training. We have multiple sites as well as individuals who work out of their homes. WBT enables us to reach all of these people with consistent and current training in a cost effective manner."

" I think it would provide an additional tool to the face to face training. I think it could be most effective for our line people where most training is visual and hands on. They could see a live version and be able to do activities according to what they saw. I don' t think web-based training could eliminate the face-to-face training. Again, it could be an extremely important additional tool."

" I think the people who use computers often or who are comfortable with computers would welcome web-based training. The people with little or no computer background would probably be less eager to participate in web-based training. Therefore, I think the value of web-based training would be dependent upon the employees. I would like it because it is convenient, although it is not very interactive to me. I like being in a class talking to people better."

2.3 Design and Development Issues.

Most of the trainers also indicated that their organizations either contract their WBI projects out or just follow the design and development procedure for the instructor-led training. For the design and development issues, they indicated.

" Follows same process as instructor-led training: (1) investigate necessity; (2) develop design spec.; (3) Develop; (4) evaluate ongoing."

"Outside vendor; try to start and educate current designers for future of course."

2.4 Other Related Factors.

For other related factors, the participated trainers identified budget, technology, time, and computer literacy of their clients as the major factors:

"Programmers, money and time. We have so many projects in the works and not enough training personnel to put it into place yet. Our operations department is almost there."

"There are two main factors. The first is budgetary; the second is computer literacy of many of our clients; internally most of our associates have the necessary software and hardware and knowledge to handle this."

"The largest concern might be security-competitors might access our training content and somehow "steal" our corporate identity. Also, I would rate the overall skill level for PC usage as remarkably low, particularly among trainers. How could we dream of developing web-based training if some of our trainers can' t use File Manager effectively?"

3 Conclusion:

The majority of the participated trainers of this study have about 5 to 6 years in designing and conducting face-to-face training, but only have about 2 to 3 months of experience in designing or receiving IBT. Most of them indicated that IBT would be a valuable addition to their companies, that their organizations have just begun to use IBT for employees or client training, that factors impacting the use of IBT include technology, cost, time, and users' computer background, and that the design and development process for IBT still follow the process used for face-to-face training.

References

[1] Genesis, N., & Hall, D. Build a web site. Prima Publishing, California, 1995.

[2] Filipczak, B. Training on intranet: The hope and the hype. Training, Vol. 33, No. 9, pp. 24-32. 1996.

[3] Majos, R., Curtin, C., Masten, D., & Glassrock, J. D. What's ahead for intranet technology: Some predictions. Training & Development, Vol. 51, No. 2, pp. 53-54, 1997.

[4] Cohen, S. Intranet: A Technology-age tool. ASTD Line, Vol. 9802, pp. 1-16, 1998.

[5] Leong, K. L. Intranet drives Ford's effort. Internetweek, Vol. 738, pp. 47-50, 1998.

A Virtual Classroom for Algorithms with Algorithmic Animation Support[1]

Shyong Jian Shyu*, Yin Te Tsai and R. C. T. Lee*****
**Department of Information Management*
Ming Chuan University
Gwei Shan, Taiwan
Email: sjshyu@mcu.edu.tw
*** Department of Computer Science and Information Management*
Providence University
Shalu, Taiwan
Email: yttsai@pu.edu.tw
**** Department of Computer Science and Information Engineering*
National Chi Nan University
Puli, Taiwan
Email: rctlee@ncnu.edu.tw

A virtual classroom on algorithms with algorithmic animation and reference database supports is presented. The cognition of algorithms might need a process of individual thinking, iterative testing and experience sharing. Our virtual classroom offers learning aids on these respects via the web. The hypermedia courseware is designed to ease the navigation. A maintenance program is devised to automatically update the hyperlinks whenever the courseware is updated. Interactive algorithm animations are applied as knowledge construction assistance. It is expected that with visualization aids learners could demonstrate their comprehension of abstract algorithms. A reference database on algorithms is built up for both educational and research purposes. Studying communications such as self-testing, bulletin board, related web links, …, etc., are also provided.

Keywords: **Multimedia and Hypermedia in Education (15), Virtual Classroom(19), Web-Based Learning(21), Algorithm Animations**

1 Introduction

The technologies of multimedia and networking on personal computers lead the research of computer-assisted learning into a new era in the last decade. Researches on the design issues of the hypermedia courseware recently please refer [17, 3, 4, 19]. Many evaluation studies also reveal positive results on learning via hypermedia courseware [7, 10, 12, 18]. With the popularity and maturity of hypermedia and web technologies, distant learning with a synchronous style via the web attracts many researchers' attention in both of the theoretical and practical points of view. The characteristics of such a web-based virtual classroom encourage the students to actively participate the construction of knowledge with their own pace and without the limitations of time and space. It is our aim in this paper to propose our design and implementation of a virtual classroom for studying algorithms with supports of interactive animations and a research paper database.

Material about algorithms is a core component for undergraduate degrees in computing. A major problem in teaching algorithms is the difficulty of capturing the dynamic movement of data and complicated data structures in static materials such as books and lecture notes [16]. Because different students learn at

---

[1] This work was supported in part by National Science Council of Republic of China under grant NSC 89-2511-S-126-003

different rates, whatever pace the lecturer chooses will be wrong for some students. A virtual algorithmic classroom would be very crucial to assist students constructing their understanding with their own pace. Further, since the abstraction of algorithms might be challenging to learn and understand, it is hoped with graphical depictions the students' comprehension could be more effective and concrete. Thus we develop animations interactively by Java in our virtual classroom.

An algorithm animation is a dynamic graphical depiction of the data and operations of an algorithm. The animation purpose is to illustrate how the algorithm functions to someone seeking to learn the algorithm [15]. Researches concerning with the studies of algorithm animation or software visualization can be found on [9, 5, 13, 15, 14, 11]. A number of practical algorithm animation systems have been built over the last ten years. Some well-known systems include
BALSA [1], Tango [13], Zeus [2], AACE [6], Zeus (http://www.research.digital.com/SRC/home.htm0),
PAVANE and Opsis (http://swarm.cs.wustl.edu/pavane.html),
ZADA (http://ls4-www.informatik.uni-dortmund.de/RVS/zada.html), ...etc.
These systems typically have been used to create animations to accompany a lecture in an electronic classroom, or to prepare animations for students to observe and interact with outside the classroom. The updated technologies of multimedia tools and web programming and a complete hypermedia courseware helping students' comprehension make our algorithmic animations differ from theirs.

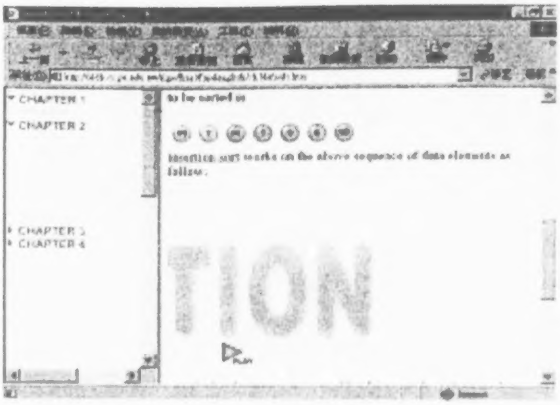
Besides the animations, in order to ease the tracing of the newest research results or referencing the related papers on algorithms, we built up a paper reference database to store research papers of algorithms, which can be queried and appended for educational or research purposes at the remote sites. We also provide some studying communication aids in a asynchronous mode such as self-testing, bulletin board, related web links, ..., etc., to improve the social communication among students in this virtual classroom.

The rest of this paper is organized as follows. The content of our algorithmic virtual classroom and the implementation result of our hypertextbook are presented in Section 2. The implemention of algorithm animations is illustrated in Section 3. The facility of the paper reference database is discussed in Section 4. Section 5 gives concluding remarks and future studying.

2 The Content of Our Algorithmic Virtual Classroom

There are four main themes in our algorithmic virtual classroom: (1) The Fundamentals of Algorithms, (2) Algorithmic Strategies, (3) Algorithmic Reference Database and (4) Studying Communications. Our design focuses on undergraduate students in science or management departments, while the database might have benefits for various kinds of users. The material is mainly based upon [8].

We re-organized the course material on algorithms as the hypermedia courseware (or hypertextbook) which helps the learners' actively exploring the knowledge. Each keyword (term or concept) on the web-courseware is linked onto its explanation page where the meaning is explained and all the links to the other occurrences in our courseware are also listed. A query facility for these keywords also provided. Consider that the course materials might be updated and the linkage relationships among keywords and their positions of occurrences on the web pages might also be changed. We developed a courseware maintenance program in C to automatically re-construct the linkage relation of all hyperlinks into its newest version whenever the courseware is updated. Figure 1 shows our hypertextbook on web. As the left frame shown in Figure 1, a tree-view browser is applied for learners to locate where he is in the courseware space. Figure 2 is the query result page of the keyword "insertion sort" which can also be reached by clicking "insertion sort" on the web content in Figure 1.



to be sorted as

Insertion sort works on the above sequence of data elements as follows:

Figure 1 The web page format of our hypertextbook

QUERY RESULT

Figure 2 The query result of the keyword "insertion sort"

The content of the four main themes is described more in detail in the following sub-sections.

2.1 The Fundamentals of Algorithms

The content in this subject includes:

(a) Celebrity Hall: The contribution of some well-known computer scientists for algorithmic study such as D. E. Knuth, R. E. Tarjan, R. M. Karp, S. A. Cook, … etc, are introduced here.

(b)The Introduction of Complexity: The concept of complexity such as order, upper bound, lower bound, … etc, are explained.

(c)The analysis of computer algorithms: The analytic models of computer algorithms are explained. Proper examples are presented also.

All of the above materials are prepared as a web hypertextbook to ease the navigation.

2.2 Algorithmic Strategies

In current stage, three strategies are ready in our web classroom: greedy, divide-and-conquer and tree searching strategies. We not only construct the hypermedia courseware but also apply interactive animations as our learning assistants. Three interactively animated examples, i.e., solving the stamp problem, the minimum spanning tree via Kruskal's and Prim's algorithms respectively, are prepared for exploring the spirit of the Greedy method, while three, i.e., finding the maximum, quick-sort and merge-sort, interactive animations are for Divide-and-Conquer and three, i.e., breadth-first-search, depth-first-search and hill-climbing, for tree searching. The implementation result is illustrated in Section 3.

2.3 Algorithmic Reference Database

It is most critical in almost every research areas, including of course the research of algorithms, to maintain a mostly updated reference database. We construct a web-based database via CGI technology to maintain those important references related to algorithms. Section 4 shows the implementation result in detail.

2.4 Study Communications

To increase the content of our courseware, we collect links of some important related web sites in our external-resource pages which enlarge the learners' view on the studying of algorithms. Meanwhile, to help students to self-evaluate the learning effect, self-tests are provided for learners to answer yes-no question sheets on the web. The system will score the result and give explanations automatically.

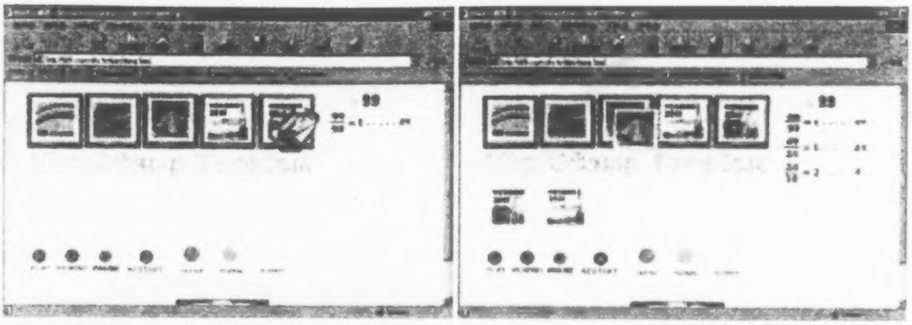
In order to improve the social communications for students in this asynchronous learning environment, we provide some interactive facilities:

(a)Bulletin board: This is an area for learners and teachers to post their idea, suggestions, questions, ...etc., on the web pages remotely. They could share the learning experience or learn from peers without the limitation of time or space.
(b)Paper up-loading: A web interface is provided for users to up-load their finding of new research papers on algorithms.

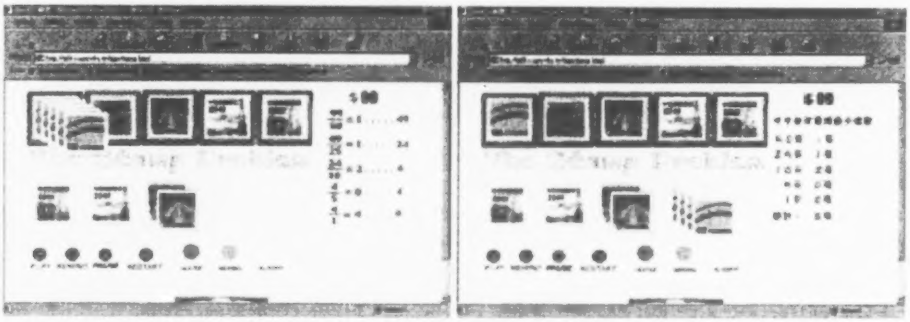
3 Interactive Algorithm Animations

Algorithm animations might be an effective tool for understanding the behavior and abstraction of algorithms. However, most approaches mentioned in Section 2 have focused on much sophisticated graphical depictions and not on the process of how learners construct their comprehensions via animations. As a way, two categories, static animation and dynamic animation, are considered in our virtual classroom. The former cannot be changed once built, while the latter might be changed according to some predefined parameters. We call the dynamic animation as interactive animation if the learners can assign values to those parameters in an on-line manner. The learners can choose either one to observe the actual data moving and to demonstrate their abstract concept. A control panel is provided for learners to control the running speed.

The static animations by Director offer multimedia presentations. Figure 3 illustrates an animated example of solving the stamp problem, which is to explain the greedy method. The interactive animations by Java allow the learners to change the animated results by assigning input variables with different values. Through observing the various running situations in terms to the given variables, learners can realize how those algorithmic steps are actually executed. It is expected that the conceptual cognition of these abstract strategies can be enhanced via the visualized running examples and the learners' comprehension could be more concrete. Figure 4 shows an example of merge-sort where the number of input instance can be assigned in an on-line manner.

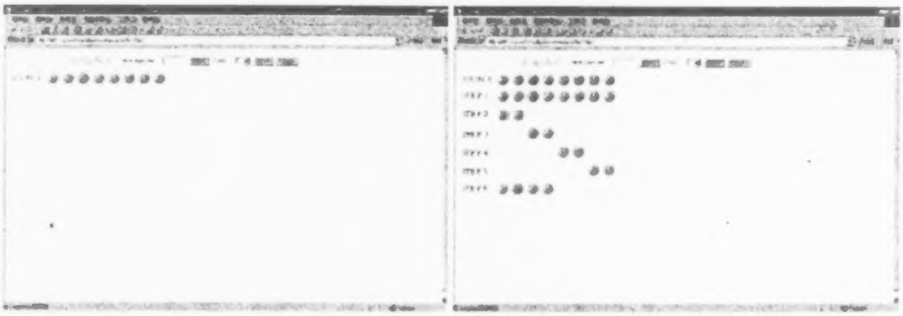


(a) the stamp with largest value is chosed (b) running with greedy

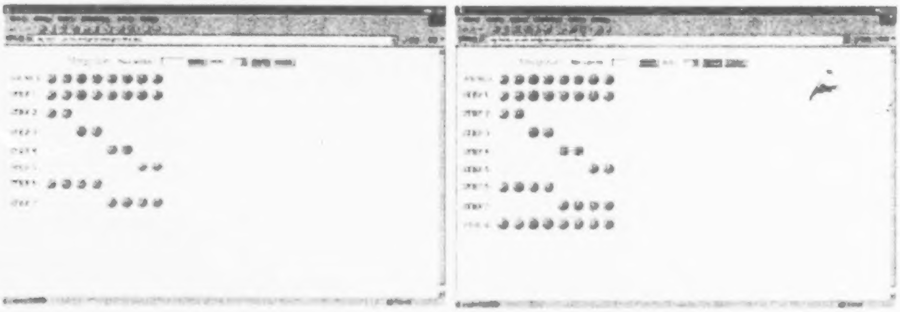


(c) running with greedy (cont.) (d) the final result

Figure 3 The static animation for the stamp problem



(a) input instance is assigned as 8 (b) the left half balls are sorted

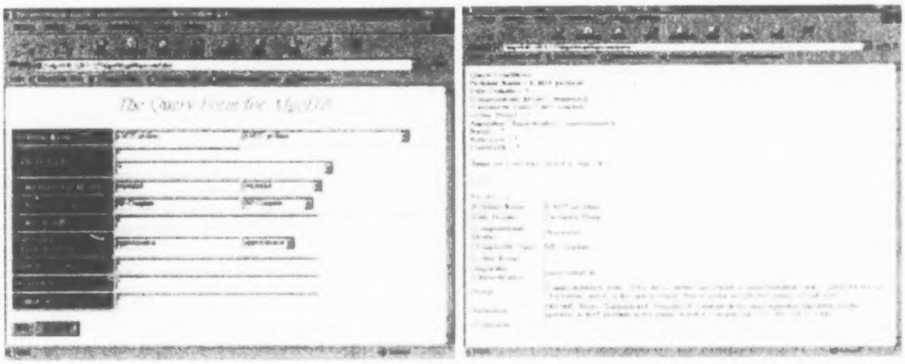


(c) the right half balls are sorted (d) the final result

Figure 4 The interactive animation for the merge-sort problem

4 Reference Database Support

To meet general researchers' requirements, it is designed to supporting query by using various fields such as: problem name, data domain, computational model, complexity class, lower bound, algorithm characteristics, result, reference and comments. It also supports the up-load functionality for interested researchers to up-load their new findings all over the world. This database is valuable not only for the researchers but also for students who could access the newest or related results at their interests. Figure 5 illustrates the query form, where k-MST problem with NP-complete complexity and other constraints are given, and the queried result of our reference database. This service would like to attract interested users' participation to our virtual classroom where discussions via the bulletin board are welcomed.



(a) a query form

(b) the quried result

Figure 5 The query and result reference database on algorithms

5 Concluding Remarks and Future Studies

We propose the design and implementation our virtual classroom for algorithms in this paper. The cognition of algorithms might need a process of individual thinking, iterative testing and experience sharing. Our virtual classroom offers learning aids on these respects via the web. It is expected that such a learning environment could help students to learn algorithms more effectively at their own pace. The hypermedia courseware will be increased and updated as a long-term project.

The activities in the traditional classroom are simulated to a great extent in our virtual classroom. However, we are not intending to give up the face-to-face interactions. The authors applied this hypermedia courseware on web as a learning assistant in a part of this semester. Students showed interests on constructing their knowledge via the hypermedia courseware and animations. Some students expressed that they supposed to understand the recursion in quick-sort before feeding data to the interactive animation, however they found their misleading after the visualization of data movement in the animation. This is one of the benefits what we intend to give in this virtual classroom. The construction of the knowledge tree is underway to help tracing the learning pattern of learners. Also an empirical evaluation of the learning effect will be studied in the near future.

The reference database gradually gathers interested researchers' attention. The authors would express their special thanks to those who up-loaded their findings of new papers and those who gave valuable suggestions.

References

[1] Brown, M. H., Exploring algorithms using Balsa-II, Computer, Vol.21, No.5, 1988, pp.14-36.

[2] Brown, M. H., ZEUS: A system for algorithm animation and multi-view editing, Proceedings of the 1991 IEEE Workshop on Visual Languages, Robe Japan, Oct. 1991, pp. 4-9.

[3] Carver, Jr., Curtis A., Howard, Richard A. and Lane, William D., Enhancing student learning through hypermedia courseware and incorporation of student learning styles, IEEE Transactions on Education, Vol. 42, No. 1, February 1999, pp.33-38.

[4] Chou, Chien, Developing hypertext-based learning courseware for computer networks: the macro and micro stages, IEEE Transactions on Education, Vol.42, No.1, February 1999, pp.39-44.

[5] Glassman, Steven, Turbo Environment for Producing Algorithm Animations, IEEE Symposium on Visual Languages, 1993, pp. 32-36.

[6] Gloor, P. A., AACE—Algorithm animation for computer science education, Proceedings of the 1992 IEEE Workshop on Visual Languages, Seattle, WA, Sept. 1992, pp. 25-31.

[7] Goodman, J. and Blake, J., Multimedia Courseware transforming the classroom, Computers in Nursing, Vol.14, No.5, 1996, pp.287-296.

[8] Lee, R. C. T., Tseng, S. S., Chang, R. C. and Tsai, Y. T., Introduction to the Design and Analysis of Algorithms, UNALIS, Taipei, 1999.

[9] Najork, M. and Brown, M. H., A Library for Visualizing Combinatorial Structures, IEEE Visualization, October, 1994.

[10] Marchionini, G. and Crane, G., (1994). Evaluating hypermedia and learning: methods and results from the Perseus project, ACM Transactions on Information Systems, Vol.12, No.1, pp.5-34.

[11] Mukherjea, Sougata and Stasko, John T., Toward Visual Debugging: Integrating Algorithm Animation Capabilities within a Source Level Debugger, ACM Transactions on Computer-Human Interaction, Vol. 1, No. 3, 1994, pp. 215-244.

[12] Novick, D. G. and Fickas, S., Collaborative Networked hypermedia education: lessons from the Nero project, International Journal of Computers and Education, Vol.24, No.3, 1995, pp.157-162.

[13] Stasko, J. T. TANGO: A framework and system for algorithm animation. Computer , Vol.23, No.9, Sept. 1990, 27-39.

[14] Stasko, et al, Software Visualization: Programming as a Multimedia Experience, MIT Press, 1998.

[15] Stasko, J. T, Using Student-Built Algorithm Animations as Learning Aids, Proceedings of the ACM Technical Symposium on Computer Science Education (SIGCSE '97), San Jose, CA, 1997, pp.25-29.

[16] Stern, Linda, Sandergaard, Harald and Naish, Lee, A Strategy for Managing Content Complexity in Algorithm Animation, ITiCSE'99, Cracow, Poland, June 1999, pp.127-130.

[17] Sun, Chuen-Tsai Chou, Chien and Lin, Bing-Kuen, Structural and navigational analysis of hypermedia courseware, *IEEE Transactions on Education*, Vol. 41, No. 4, November 1998, pp.347-357.

[18] Thuring, M. Hannemann, J. and Haake, J. M. (1995). Hypermedia and cognition - designing for comprehension. *Communications of the ACM*, Vol.38, No.8, pp.57-66.

[19] Valdes, D., Moure, M. J. and Mandado, E., Hypermedia: A Tool for Teaching Complex Technologies, *IEEE Transactions on Education*, Vol. 42, No. 4, November 1999, pp.361-376.

A Web-based Interactive Exercise System for Learning Mathematical Functions

Takayoshi Yoshioka, Yuzo Higuchi and Hitoshi Nishizawa
Toyota National College of Technology
2-1 Eisei-cho, Toyota, 471-8525, JAPAN
Tel: +81-565-36-5852, 5849, Fax: +81-565-36-5925
E-mail: {yoshioka, nisizawa}@toyota-ct.ac.jp

1 Introduction

Although exercises are important in learning fundamental mathematics, it is not easy to provide an appropriate exercise for every student in a class because the understanding level and the calculating skill of the student usually differs widely. Computer systems storing problems for the exercises and learning histories of the students might help the situation. The system should also have some intelligence in evaluating students' answers for making it closer to the written exercises and going beyond the multiple choice questions [1].

CAS and graphic calculators have some intelligence in a way. They calculate or operate mathematical expressions symbolically, show the graphs of functions immediately. But the use of them does not always help the students to understand the mathematical concepts or the meanings of the operations [2]. They might become black boxes that hide not only the detailed process of the calculation but also the mathematical ideas lying behind them.

The authors have been developing a Web-based interactive exercise system since 1996 and have been using it as a supporting tool for teaching mathematics to our students [3]. The purpose of developing the exercise system is to change the roles of the students and the CAS. We want the students to think or guess in their exercises and the CAS to assist them for giving some meaningful hints for solving problems by themselves.

2 Interactive Exercise System

The exercise system described in this paper consists of networked computers for students and a WWW server collaborating with a database and a CAS, MATHEMATICA™ as the evaluation engine [4], which allows the students wide variety of mathematical expressions for their inputs. An evaluation is done by MATHEMATICA™ according to the rules described in custom evaluation functions coded with MATHEMATICA™ language [5]. It evaluates the students' inputs symbolically and returns more meaningful comments than correct or not. More detailed description of the structure of the system and some examples of the interactive exercises implemented on it have already been reported [3, 5].

The system, however, needs shorter response time for the exercise of expressing the mathematical function of a given graph. The exercise shows a student a graph of a function, asking to express the function as a mathematical expression (Fig. 1).

It gives the student several input fields for typing his/her expressions in. The expressions are sent to the server and compared with the answer symbolically by MATHEMATICA™. If one of the expression is equal to the answer, a simple comment "right expression" is returned to the student.

If no expressions are equal to the answer, comments describing the difference between the expressions and the answer are returned instead. A graphic image showing both the answer in blue color and the last expression in red color is also displayed, which helps the student to realize the difference visually. Every evaluation gives some hints toward the right expression, which allow the student to learn from his/her mistakes.

3 Processing Time for the Evaluations

The new exercise needed more evaluation time than the other exercises when Macintosh was used as the server machine. Although the new exercise itself is most popular among the students, the long waiting time hindered it's regular usage. Technically, the biggest difference of the exercise from the others is that MATHEMATICA™ creates a new graphic file dynamically every time at the evaluation and the file is embedded into the HTML for the exercise page. The long waiting time was caused by the process of creating the graphic file.

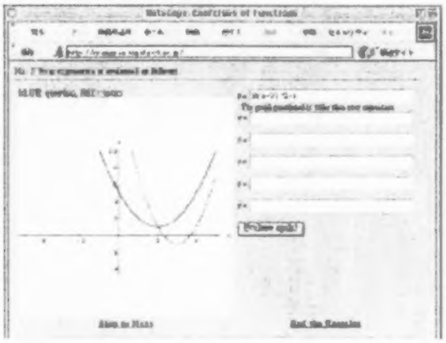


Fig.1 A student' s Web-page after the evaluation

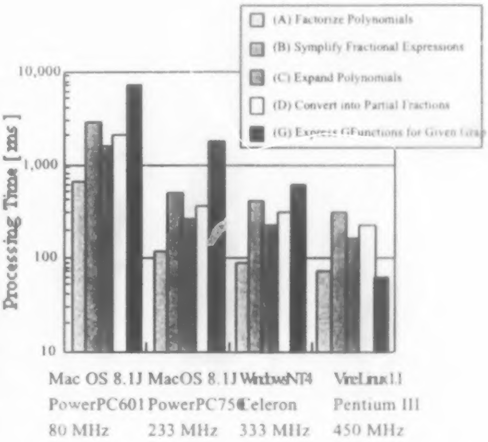


Fig.2 CPUs' processing time for the evaluations

We compared the CPU's processing time needed when MATHEMATICA™ evaluates expressions according to the rules described in the evaluation functions for the system (Fig. 2). There are four exercises of; (A) factorizing a polynomial, (B) simplifying a fractional expression, (C) expanding a polynomial, and (D) converting into partial fractional expressions, each of which needs only symbolic evaluation, and an exercise of expressing the function for given a graph (G) which lets the system create a new graphic file adding to the symbolic evaluation. The measurement was done using several server machines running different operating systems, i.e. Macintosh OS, WindowsNT, and Linux. Although the server machines used to run those operating systems are different in the type of CPU and the clock speed, we thought that the clock frequency of the CPU becomes a rough measure of the performance of a server, which consist of hardware and an operating system.

When we use Macintosh OS or WindowsNT for the operating system of the server, the evaluation of "expressing the function for a given graph" takes more processing time than the other exercises which does not create any graphic files. The processing time decreases with the clock frequency of the CPU and the exercise (G) consumes the longest processing time. If we select a PC running Linux as the server, the tendency is reversed. The evaluation which creates a graphic file becomes the shortest process on the sever while the processing time for the other exercises have same tendency. If we compare the Linux machine (450 MHz) with the WindowsNT machine (333 MHz), the processing time is 1/10 for the exercise (G) while it is 1/1.38 in the exercise (D), and the clock frequency of the CPU is 1.35. Changing the operating system for the server must be the most cost-effective improvement for the response when we put the exercise (G) into wider use.

4 Conclusions

A Web-based interactive exercise system has been extended to serve a new exercise of expressing the function for a given graph. MATHEMATICA™, a CAS used in the system as the evaluation engine, has far better performance on Linux than on Macintosh OS or WindowsNT for the new evaluation when it creates a new graphic file. The increased performance will make the exercise to be used regularly.

References

1) Pitcher, N., Goldfinch, J., Beevers, C., "Computer base assessment: beyond multiple choice", Proceedings of ICTMT4, P31 (1999).
2) Hong, Y. Y. & Thomas, M., "Super-Calculators and Mathematics Examinations", Proceedings of ICCE'99, vol.2, pp483-490 (1999).
3) Hypermedia Learning Environment, http://orange.ee.toyota-ct.ac.jp/defaultE.html (accessed on July 25, 2000).
4) Miyaji, C., "Network Programming with Mathematica" (in Japanese), Iwanami shoten (1998).
5) Nishizawa, H., Saito, H., Pohjolainen, S., "Evaluation Methods of Mathematical Expressions in On-line Exercises on Expanding Polynomials and Simplifying Rational Expressions", Proceedings of ICTMT4, P52 (1999).

Adaptive Programming Language Tutoring System on the Web

Jin-woo Choi and Chong-woo Woo
Department of Computer Science, Kookmin University
861-1 Chongnung-Dong, Sungbuk-ku, Seoul, Korea
Tel: +82-2-910-4795
Fax: +82-2-910-4799
Email: cwwoo@kmu.kookmin.ac.kr

Many of the web-based educational systems could not provide an individualized instruction or an interactive problem solving, since they are mostly built upon static hypertext. One possible approach to solve these problems could be adapting the existing proven techniques from the stand-alone Intelligent Tutoring System(ITS). Some recent web-based ITS researches show this efforts by employing the techniques selectively, and this needs to be studied further to support more effective web-based instruction. In this paper, we describe the design and the development of a Web based Adaptive programming Language Tutoring System(WALTS). The system is designed based on the ITS structure primarily, and it is adapting previous ITS techniques into the system successfully. Especially our focus is on the three levels of the instructional planning mechanism, which can generate lesson contents dynamically whenever it is requested. This way we do not need to crate all the lesson contents in HTML forms which must reside in the system in advance. In addition, the system has adapted CORBA structure to support the user more consistent and reliable performance. Together, the system behaves more adaptive and interactive, than the existing non-ITS based web systems. The test domain of the system is learning C programming language for the first year computer science student.

Keywords: **Web-based learning system, Intelligent Tutoring System, Instructional planning**

1 Introduction

Many recent web-based educational systems could not provide an individualized instruction or an interactive problem solving, since they are mostly built upon static hypertext. One possible approach to solve these problems could be adapting the existing techniques from the stand-alone ITS. Brusilovsky[2] states that some ITS techniques can be adapted into a web-based educational system, and divides the techniques into three distinctive parts, such as, automatic creation of curriculum, dynamic problem solving, and intelligent analysis of student model. However, most of the recent web-based ITS research show the efforts by employing the techniques selectively[2][3][4][7], such as adapting student modeling or problem solving capability at some level. Therefore, this needs to be studied further to enhance the overall capabilities of the system at the previous stand-alone ITS level. For instance, automatic generation of curriculum or lesson plan is necessary to provide a flexible instruction for each individual user.

In this paper, we describe the design and development of Web-based Adaptive programming Language Tutoring System(WALTS). The system is designed based on the ITS structure primarily, and it is adapting many techniques from the stand-alone ITS into the web-based systems. First, we designed the knowledge base using the object-oriented method in order to handle flexible management of object inheritance and tutorial strategies. Second, the student modeler can avoid the network traffic by designing the modeler stays in the server-side at the beginning of the session for maintaining necessary administration duties, and creates an individual student model in the client side. And the third important approach is having the instructional planning mechanism, which generates lesson contents dynamically for each individual user. This is important feature for moving towards the web-based system, because most web-based educational systems creates all the lesson contents in HTML forms in advance, and they must reside in the system physically. And then the user navigates the system for learning, such as in ELM-ART[2] or CALAT[4]. Intelligent navigation strategy might be one of the intelligent way of guiding the user to learn the material, but rather inefficient compare to the dynamic generation of lesson contents. WALTS only generates the necessary lesson contents whenever it is requested by the system, which can be another advantage. In addition, we have approached distributed architecture by employing CORBA(Common Object Request Broker Architecture) structure to support the user more consistent and reliable performance while the user using the system. The initial web-based educational systems are mostly developed by using the CGI(Common Gateway Interface) techniques, which often results in bottleneck problem when many users access the system at the same time. In this sense, our structure might avoid such a problem, and the system could also be easily updated when we need to revise some part of the system. Together, the system behaves more adaptive and interactive, than the existing non-ITS web-based educational systems. The test domain of the system is learning C programming language for the first year computer science student.

The rest of the paper is organized as follows. In section 2 we described a distributed infrastructure of WALTS system. Section 3 presents each components of the system and also some intelligent aspects of the system. We conclude the paper in section 4.

2 Distributed infrastructure

The previous web-based educational systems have been built as either a server-based architecture or a client-based architecture[6]. Each of them has some advantages and disadvantages. The server-side architecture mostly rely on CGI techniques, which has shown some problems of handling complex client/server communication because of its connectionless feature. Also client-side architecture needs to have all the plug-ins installed on client computer before using the system. Therefore the recent web-based applications tend to adapt CORBA or Java based distributed infrastructure. That is free from the connectionless or stateless problem, and also has some advantages of distributed system technology, such as message passing, RPC(Remote Procedure Call), and proprietary communication protocol. The client connects to the server using the HTTP protocol only for the initial connection, and after the downloading the specific mobile code application(for example, client side application, JavaScript, Java Applet, and etc), the client use the proprietary protocol(non-HTTP), so it does not communicates with web server, but communicates with proprietary server(non-Web server).

WALTS employed CORBA to adapt this kind of distributed infrastructure. The system is designed by HTTP server which takes care of user requests and responses, and CORBA-based server which performs the capabilities of the ITS. Also the system could be easily re-organized if we want to modify the structure later on [see figure 1]. In short, one of the major advantages of WALTS is that it can easily avoid the bottle-neck problem of CGI techniques, and also we believe that this style of architecture might be another best solution for building web-based client/server educational system.

3 Basic architecture of the system

The basic architecture of WALTS is designed by typical ITS structure primarily, including expert module, the student modeler module, and the instructional planning module.

3.1 The expert module

The expert module of the system consists of the object-oriented knowledge base, and the problem solver.

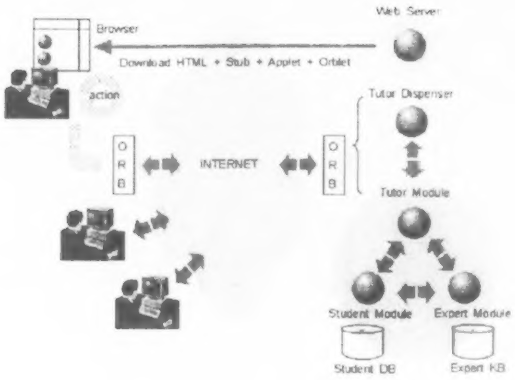


Figure1 The main architecture of the WALTS

Object Oriented-based knowledge base. First, we employed the frame knowledge representation techniques for the main knowledge base. Because the domain knowledge does not require any complex causal relationships, but rather it is consists of simple C language concepts. The object-oriented approach make it easy to modify the data type, can reduce the knowledge base reference by having slot values as member data, and can provide more flexibility for updating or manipulating tutoring strategy [5].

In this system we designed a frame with several meaningful slots, and each frame does not have to have the same number of slots, since the inference engine can get all the necessary informations due to the inheritance feature of the system. The 'type' slot can possess a concept, example, or quiz. The 'source' slot points to its superior frames. The 'Pfame' and 'CFrame' slot is necessary when we need to show the related nodes in linked list structure. The 'reference' slot may contain all the necessary frame names that are related to the current frame. This kind of slot structure is very common in every frame structure, and also important in object-oriented structure, because each frame can have common attributes and can generate an object of having its own attribute. Also, the system allows an abstract class, which plays the backbone of the system, and supports a hierarchical structure, and the definition of the method can be done only in the lower class [figure 2].

Frame Variable Declaration Quiz
[Source] Chapter1-3-1-1
[Type] Quiz
[Title] Variable declaration Quiz
[Template] Data Type | Variable | General Grammar
1 : Select the correct %type variable declaration
2 : ...
[PFrame] Variable Declaration
[CFrame] Null

Figure2 Variable declaration quiz frame

The Problem Solver. WALTS can generate a problem dynamically depending on the current topic. Since the planner knows what is being taught at the moment by generating a lesson unit, the tutor can decides whether it is 'teaching concept' or 'show example' or 'quiz'. At the moment, we have only three styles of lesson unit. If it is a 'teaching concept', the planner sends the lesson unit to the user in HTML form. If it is a 'quiz' type, then planner requests the problem solver to generate a question. The problem solver first creates a problem table by referring to the current lesson unit. The generating and solving a problem occurs at the same time, and the solver stores the correct answer. And then, it presents the generated questions to the user in appropriate HTML form through the HTML generator. This method can provide different styles of questions for different users even though they are accessing the same lesson unit, which can be another advantage of WALTS. Since the column name of the table is object's name, the planner can reply to the user's request, such as hint or help, by referencing this table.

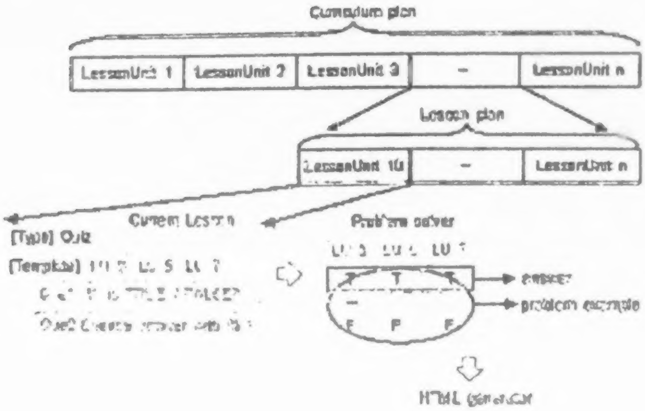

Curriculum plan
LessonUnit 1
LessonUnit 2
LessonUnit 3
–
LessonUnit n
Lesson plan
LessonUnit 10
–
LessonUnit n
Current Lesson
Problem solver
[Type] Quiz
[Template]
T
F
answer
problem example
HTML generator

Figure3 Creation of a quiz for 'variable declaration'

The strategy of asking user for answering quiz is multiple choices. So that we need to generate problems along with the appropriate multiple choice answers also. For instance, let us think about a simple quiz about asking user 'a data type'. A typical 'data type' is consists of three parts, for example, 'int x ;'.The 'int' is a data type integer, 'x' is a user-defined variable name, and ';' is needed for ending a sentence in C language. We are trying to generate this simple data type declaration statement sentence as follows. First, the data type 'template' slot consists of three parts as in [Figure 3]. Then we can generate eight different answers as in [Figure 5], since each one part of a statement can be correct or incorrect. And we can select some of them randomly including correct answer; the numbered answers are selected ones in the figure. And also we can obtain designated unit object's content as in [Figure 4]. The generated correct answer is stored in memory, and then later it is compared with the user's answer. For example, if the user selected number 2 as in [figure 5], we can analyze that the user does not know about reserved word. And the planner needs to revise the lesson plan to correct the misconceptions by giving special messages, such as hint or help, and then the planner re-organizes the lesson plan including 'reserved word' lesson unit. The [figure 6] shows a sample session of solving a generated quiz.

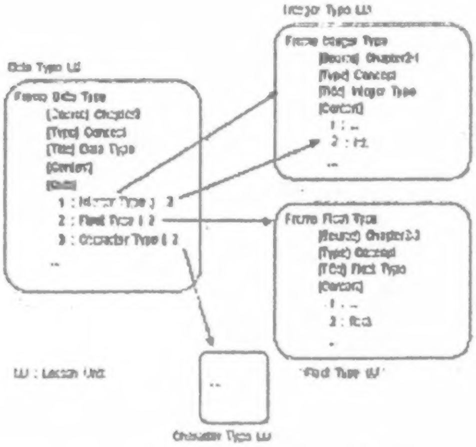

Integer Type LU
Data Type LU
Frame Data Type
[Source] Chapter3
[Type] Concept
[Title] Data Type
[Content]
[Child]
1 : Integer Type ( ) 2
2 : Float Type ( ) 2
3 : Character Type ( ) 2
...
Frame Integer Type
[Source] Chapter2-1
[Type] Concept
[Title] Integer Type
[Content]
1 : ...
2 : int
...
Frame Float Type
[Source] Chapter2-3
[Type] Concept
[Title] Float Type
[Content]
1 : ...
2 : float
LU : Lesson Unit
Float Type LU
Character Type LU

Figure4 Data type unit frame

Data Type	Variable	General Grammer	
T	T	T	← ④
T	T	F	
T	F	T	← ③
T	F	F	← ①
F	T	T	
F	T	F	← ⑦
F	F	T	
F	F	F	

Figure5 Table for possible answers for data type quiz

3.2 The Instructional Planner

The most web-based educational systems built upon hypertext, which is hard to make hyperlink in every HTML pages, and also needs to have carefully designed navigation strategy[2]. And also all the lesson contents are built as HTML pages in advance, and must reside in the system physically. We believe that generating a lesson plan dynamically, for each individual user, is more efficient than the above approaches. Therefore, we adapted the traditional ITS instructional planning mechanism into the system. The instructional planning of the WALTS can be further divided into 3 steps, a curriculum planning, a lesson planning, and a delivery planning. The curriculum planning of WALTS generates a curriculum in tree structure; the curriculum planner extracts information from the knowledge base and creates a curriculum hierarchically in the order of prerequisites. Then the lesson planning sets up the lesson sequence within a single lesson unit. The role of delivery planning is limited to presenting the selected lesson content to the user.

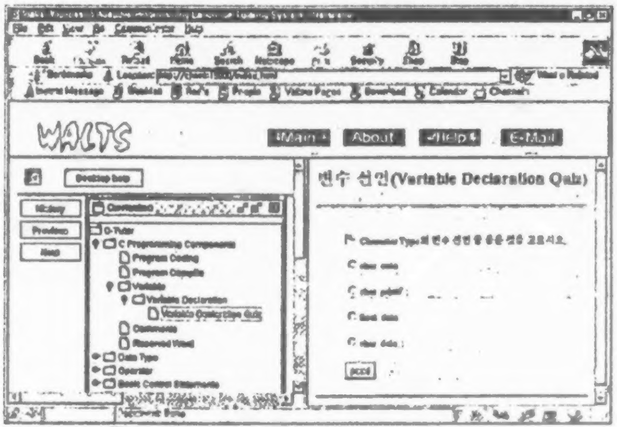


Figure6 An example of solving a generated quiz

Curriculum planning. The purpose of the curriculum planning is to provide a curriculum to the user, in other words, to provide an individualized optimal learning path to the user[1]. The generated curriculum is in the form of a tree structure. It is constructed by creating an initial node by referencing the value of the attributes in the lesson unit slot, and further expands the structure in the order of the way the student must learn, which will be accessed as linked list structure. The lesson unit of the system is organized according to some basic rule, such as the student must learn prerequisite concept first and the move to the next topic. So the curriculum is set up in the form of hierarchical and linear sequence.

Lesson Planning. The lesson planner generates a lesson plan by referencing the curriculum and the student model. The information from the student model shows the results from single lesson unit and based on this record, the planner sets up appropriate lesson plan for the student. When the student selects other learning path on purpose before the current lesson plan is finished, the system must decide what to do next, such as whether to store the current lesson plan and execute the user's request, and then resume the current plan or destroy the current plan and re-plan the whole sequence all over again. In that sense, WALTS uses re-planning strategy when the user wants to quit the current topic, and move to another learning path. Another case of re-planning occurs when the student made an error on the selected quiz lesson unit. If the student made a mistake on this, the current lesson plan is suspended, and another new lesson plan is created to correct the student's error. After the remediation process is finished, the suspended plan will be resumed.

Delivery Planning. The lesson unit has been generated by lesson planner and needs to be delivered to the user. The possible delivery tactic in this domain could be "present concept, show example, give exercise, and etc". Of course if the system allows mixed-initiative control, the delivery planning needs to be more sophisticated in order to handle all the user request or questions. The delivery planning part of the WALTS is made of simple structure, and will be enhanced further in the next research.

The HTML generator. The very distinctive feature of the system is the HTML generator. This feature can be regarded as the interface part of the system. When the delivery planner decides the immediate unit lesson, the content of the lesson is converted into HTML form by the HTML generator. The HTML generator generates HTML pages according to the HTML2.0 protocol and inserts "next" or "previous" button in order to navigate adaptive learning path. But if the lesson unit contains some applet, the system directly searches the physical location and sends the URL to the student's browser without consulting HTML Generator. The [figure 7] describes the HTML generator sends two different results to two different users, since their learning background is different.

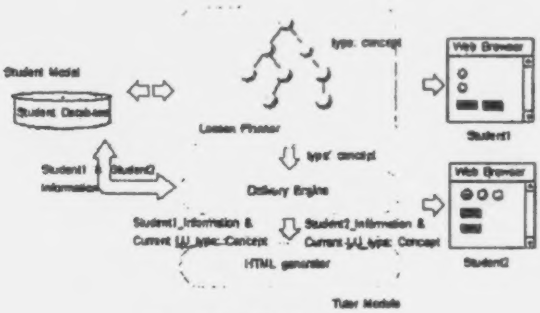


Figure7 The HTML generator

3.3 The student modeler

The strategy for building the student modeler is the simple overlay, which simply reflects user's learning process about current topic. And this should be enhanced by including the buggy information later on. But an important enhancement is that the student modeler of WALTS can avoid the unnecessary network traffic. For instance, if the system maintains the student model in the server-side, then whenever the user accesses the system the server needs to update the user's student model in the server. This may cause another bottleneck problem, and the most CGI-based systems still have this problem. Our approach on the student modeler is as follows. The server-side student modeler creates a table, and keeps all the necessary administrative informations on the server-side, such as initial student's ID, password, e-mail address, the access time[figure 8], which can be used for various administrator purposes. And the information regarding the student's learning process is stored in the student model[figure9], which is created in the client-side machine for each individual user whenever they logged on. The student model has several parameters that reflect th[illegible]udent's learning history, and each parameter has unique meanings. For example, 'the 'HelpCount', means how many times the user has been helped, and 'HintCount' means how many times the user has requested hints, and they can be updated only when the 'unit lesson' is quiz. The 'ReferenceCount' means the user is weak at the current unit lesson since the specific lesson has been accessed more often than other frames. The 'LessonLevel' stores information about how the level of the current topic, and the 'LessonType' means whether the current unit lesson is concept, example, or quiz, and so on.

BEST COPY AVAILABLE

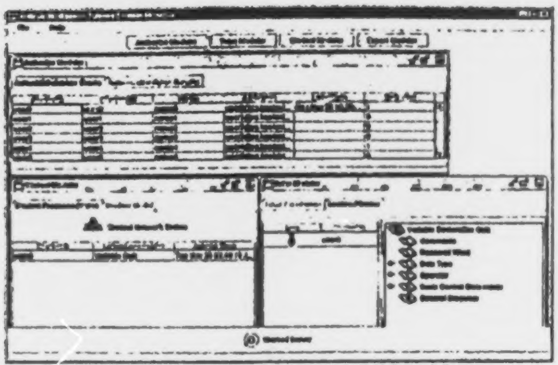
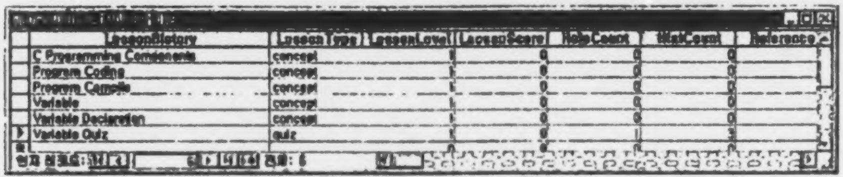


Figure8 The Server-side student modeler table



	LessonHistory	LessonType	LessonLevel	LessonScore	HelpCount	[illegible]	Reference
	C Programming Components	concept	1	0	0	0	
	Program Coding	concept	1	0	0	0	
	Program Compile	concept	1	0	0	0	
	Variable	concept	1	0	0	0	
	Variable Declaration	concept	1	0	0	0	
▶	Variable Quiz	quiz	1	0	1	3	

Figure9 The student model

4 Conclusion

We have designed and implemented a web-based ITS, WALTS, which is a learning C programming language tutor aiming for the first year computer science students. The main goal of this paper is, first, the adaptation of the existing ITS techniques into the web platform. Therefore, we have designed and implemented the system based on the major ITS architecture, and this brings us several advantages over traditional HTML-based educational systems. First, the main knowledge base is created as an object-oriented concept, which can provide more flexibility for manipulating frame objects and tutoring strategy also. Second, we have generated a quiz dynamically by the problem solver and also can solve the problem. Third, we designed a student modeler that can avoid the network traffic in the minimal, by having the modeler in the server-side, and creates an individual student model in the client-side. Fourth, the instructional planner can generate an instructional plan dynamically, and this is another advancement of building web-based ITS, since the current web-based ITS research shows further work on this subject. Additional issue of the paper is that we designed the system as the distributed infrastructure using CORBA as backbone of the system. This structure solves the bottleneck problem of previous CGI dependent systems, and also gives some benefits of better performance and also gives flexibility in the case of further enhancement of the system.

References

[1] P. Brusilovsky. "Adaptive Educational Systems on the World-Wide-Web: A Review of Available Technologies" http://www-aml.cs.umass.edu/~stern/webits/itsworkshop/brusilovsky.html

[2] P. Brusilovsky, E. Schwarz, and G. Weber. "ELM-ART: An Intelligent Tutoring System on the WWW." The Proceedings of ITS'96, pp261-269, Springer, (1996).

[3] J. Kay and R.J. Kummerfeld "An Individualized Course for the C Programming Language." The Proceedings of 2nd International WWW Conference, Chicago, IL, pp17-20, (1994).

[4] K. Nakabayashi, M. Maruyama, Y. Koike, Y. Kato, H. Touhei, and Y. Fukuhara. "Architecture of an Intelligent Tutoring System on the WWW." The Proceedings of AI-ED'97, pp39-46, (1997).

[5] K. Nakabayashi, H. Touhei, S. Hitoshi, and Y. Fukuhara. "An Object-Oriented Architecture for a Web-based CAI System", The Proceedings of EDMEDIA'98, (1998).

[6] A. Silva, M. Silva, and J. Delgado. "A Survey of Web information Systems." The Proceedings of WebNet'97, pp520-530, (1997).

[7] M. Stern, B. Woolf, and J. Kurose, "Intelligence on the Web?," The Proceedings of AI-ED'97, pp490-497, (1997).

An Adaptive Navigation Support with Reorganized Learning Resources for Web-based Learning

Shinobu Hasegawa, Akihiro Kashihara, and Jun' ich Toyoda
The Institute of Scientific and Industrial Research, Osaka University,
8-1, Mihogaoka Ibaraki Osaka, 567-0047 JAPAN
Tel: +81-6-6879-8426
Fax: +81-6-6879-8428
E-mail: hasegawa@ai.sanken.osaka-u.ac.jp

On the Web, there are diverse learning resources with the same learning topic, each of which is designed by different authors. Properly using these web-based resources, learners can study the topic from diverse points of view. This is one of the prominent merits of web-based learning. However, learners would have difficulty in finding a learning resource suitable to their learning contexts because there are currently an enormous number of learning resources on the Web and because most web-based learning resources do not have a clear description of their characteristics such as what kind of learners should use, what kind of learning goal can be achieved. Our approach to this issue is to reorganize web-based learning resources with indexes called resource indexes representing their characteristics, and to provide learners with an adaptive navigation support, which recommends them some learning resources to be learned next in accordance with their needs and knowledge states. We also report a preliminary experiment to evaluate the validity of the adaptive navigation support with a demonstration system. From the results of this experiment, we have made sure that it is valid.

Keywords: **Learning Resource, Web-based Learning, Resource Index, Resource Navigation**

1 Introduction

Over the past several years, an increasing number of hypermedia/hyperdocuments based resources on the Web have been available, which are designed from an educational point of view, or which are worth learning. Learning with such existing web-based resources has accordingly become more important, particularly as the realization of lifelong and distance learning [1].

On the Web, there are many learning resources with the same topic, each of which is designed by different authors. Some of them are suitable for augmenting domain concepts/knowledge in the topic. Some are also suitable for having a deeper understanding of the topic with examples/simulation/illustration, or applying knowledge with exercises. Properly using these kinds of learning resources, learners can study the topic from diverse points of view. This is a prominent merit of learning a topic on the Web.

This paper describes a web-based learning environment that makes use of diverse learning resources involving a certain topic to promote learning. The main issue addressed here is how to help learners select some instructive learning resources according to their learning contexts. There are currently an enormous number of learning resources on the Web. In addition, most web-based learning resources do not have a clear description of what kind of learners should use, what kind of learning goal can be achieved and so on [7]. Learners consequently have difficulty in finding an instructive learning resource [4].

The approach presented in this paper is to reorganize web-based learning resources with indexes called resource indexes representing their characteristics, and to build a learning resource database. At present, there exist a number of Web sites collecting URLs of web-based learning resources. These sites use resource indexes, which mainly represent learning topics/subjects, to classify the learning resources. The resource indexes allow learners to know what they can learn beforehand. In other words, they can select learning resources from a "what to learn" point of view. However, the indexes are not enough for them to find a learning resource suitable to their learning contexts since they would usually think of not only "what to learn" but also "how to learn". They would particularly think of in which learning phase they try to learn. There are generally several phases of learning a topic such as augmenting new knowledge/information about the topic, deepening understanding of knowledge, applying/stabilizing knowledge, etc [5]. Which learning resource to select depends on in which phase learners try to learn. Learning phases should be accordingly represented as resource indexes.

In this paper, we propose a way to reorganize web-based learning resources with "how to learn" indexes (HTL indexes for short) including learning phases in addition to conventional "what to learn" indexes (WTL indexes for short), building a learning resource database. We also demonstrate an adaptive navigation support with the database, which recommends learners some resources to be learned next in accordance with their learning contexts such as needs and knowledge states. This aims to promote their learning from knowledge accretion phase to knowledge stabilization phase.

In the following sections, we first describe the way to build a learning resource database with WTL and HTL indexes. Next, we demonstrate the adaptive navigation support with the database. Furthermore, we report a preliminary experiment to evaluate the validity of the adaptive navigation support. From the results of this experiment, we have made sure that it is useful.

2 Reorganizing Web-based Learning Resources

2.1 Learning with Existing Resources on the Web

Before discussing the way to reorganize learning resources on the Web, let us first consider learning with them. In this paper, a learning resource means a hyperdocument, which describes a learning topic within a Web site. It provides learners with a hyperspace that consists of a number of Web pages. Learners can explore the hyperspace to learn domain concepts/knowledge [2], [6]. On the Web, in addition, there are diverse learning resources with the same topic, which could facilitate diverse learning phases such as augmenting and applying domain concepts/knowledge. Properly using these learning resources, learners can study the topic from diverse points of view.

As shown in Figure 1, we view web-based learning as learning a topic in three phases and as the transition between learning phases. The learning phases are as follows: accretion, understanding, and stabilization [3]. Each phase is also explained as follows:

- Accretion phase is the one in which domain concepts/knowledge are augmented;
- Understanding phase is the one in which known concepts/knowledge are understood with examples, simulations, illustrations, etc.;
- Stabilization phase is the one in which known concepts/knowledge are stabilized by means of problem-solving with exercises.

The transition between learning phases is expected to occur according to completion or impasse of learning in a phase. It is also expected to take place from knowledge accretion phase to knowledge stabilization phase or in the opposite direction. Learners' knowledge is finally expected to stabilize. However, learners need not always start learning from the accretion phase. They can start learning from any learning phase according to their knowledge states.

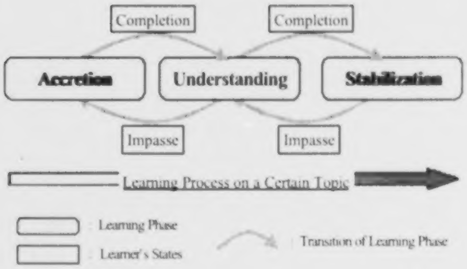


Figure 1 Web-based Learning

Table 1 Resource Index

WTL Index	Academic Year Subject Learning Topic	
HTL Index	Learning Phase	Accretion Understanding Stabilization
	Media	Texts only Graphics Animations Sounds Simulations E-Mail BBS, Chat Others
	Communication Channel	High Immediacy High Interactivit Questions and A

2.2 Resource Index

In learning a topic, learners would select a learning resource according to their knowledge states. However, most existing learning resources on the Web do not usually have a clear description about which learning phase could be facilitated. Therefore, the proper selection of learning resource is not so easy for them. One way to resolve this problem is to provide learners with a learning resource database.

There currently exist many Web sites, which collect URLs of web-based learning resources. In these sites, they are classified with resource indexes that mainly represent learning subjects/topics. These indexes allow learners to select learning resources from a "what to learn" point of view. However, such indexes are not enough for them to find a learning resource according to their learning contexts. When a learner wants to stabilize his/her knowledge of a topic, for example, he/she could select a learning resource suitable for augmenting knowledge about the topic. Learners would usually think of not only "what to learn" but also "how to learn" especially in which learning phase they should learn.

We have consequently provided resource indexes that consist of "How To Learn (HTL)" indexes in addition to conventional "What To Learn (WTL)" indexes, and have proposed a way to reorganize learning resources. In helping learners select learning resources proper for the transition between learning phases as shown in Figure 1, "learning phase" is first most important as HTL indexes. In helping learners continue learning in a phase, second, some HTL indexes are necessary for differentiating learning resources that could facilitate the phase. In fact, some learners may try to resolve an impasse, which occurs in one resource, with other resources that could facilitate the same learning phase. Considering web-based learning resources with the same topic, we can see various media for representing the contents such as text, diagram, chart, illustration, etc. We can also see various interactive/real time environments such as simulation, chat, BBS, etc. Such media and communication channels would have an influence on how to learn. In addition to learning phase, we accordingly regard them as HTL indexes as shown in Table 1.

2.3 Reorganization

Figure 2 shows how to reorganize learning resources with WTL and HTL indexes. First, the learning resources are classified with WTL indexes so that learners can see from a "what to learn" point of view. Next, the resources are classified with learning phases so that learners can select from a number of learning resources with one topic. Some learning resources may have two or three indexes of learning phase. Finally, indexes of media and communication channels are attached to each learning resource as its attributes so that learners can select from a number of resources that could facilitate the same learning phase.

Following the above way, we have implemented a learning resource database where many existing resources have been indexed. We have also addressed the issue of how to support indexing (See [5] for more detail).

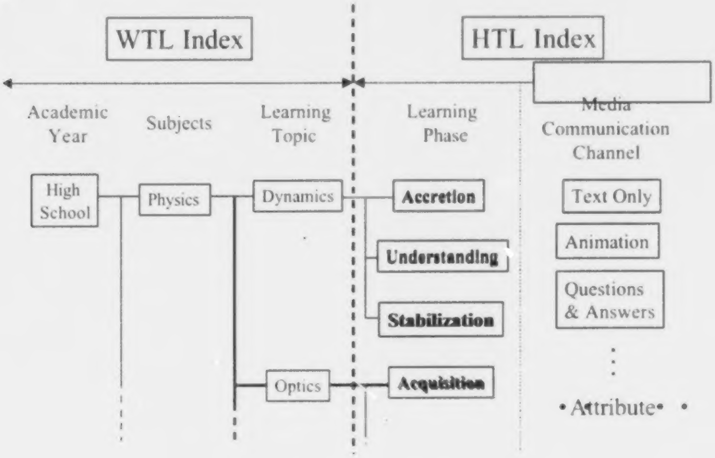


Figure 2 Hierarchy of Indexes

3 Adaptive Navigation Support

3.1 Learning Resource Navigation

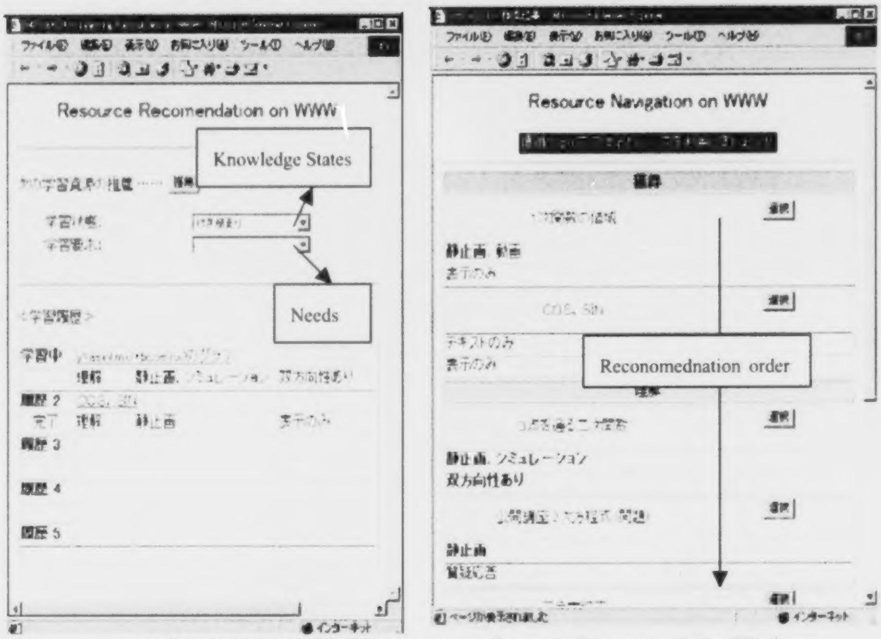
Let us now introduce an adaptive navigation support with the learning resource database. Although the resource indexes allow learners to search learning resources they want to learn, it is still difficult for them to select a learning resource in accordance with their learning contexts to promote learning from knowledge accretion to knowledge stabilization. We have accordingly proposed a navigation support, which recommends learning resources to be learned next according to learners' knowledge states and needs.

The main aim of this support is to promote learning of a specific topic with diverse learning resources so that learners' knowledge can be stabilized. For this aim, in particular, it attempts to facilitate the transition between learning phases and to change media/communication channels for promoting learning in one phase. If a learner reaches an impasse in the understanding phase, for example, he/she is encouraged to return to the accretion phase to resolve it. If he/she completes the understanding phase, on the other hand, he/she is encouraged to move to the next phase that is stabilization phase. He/she is alternatively encouraged to continue learning in the same phase with different resources that have different media/communication channels.

3.2 Recommendation

Let us next explain how to execute the learning resource recommendation in accordance with learners' knowledge states and needs. In the navigation support, we consider two knowledge states: impasses and completion of learning a resource. Learners are asked which state they reach after learning the resource. If necessary, they can also demand change of media/communication channels for a learning resource to be learned next as their needs.

The learning resource recommendation uses the information given by the learners to make a list of learning resources to be learned next. The learning resources are put in the order of priority. The aim of the recommendation is not to give the learners the most instructive resource from the database. The list provides them with a guide in selecting instructive learning resources.



< Learner' s Input Window>   <Resource Recommendation Window>

Figure 3 Resource Navigation System Interface

Figure 3 shows the interface of the prototype system for adaptive navigation support. This system, implemented with Common Gateway Interface (CGI), consists of two windows. The left window enables learners to input their needs and knowledge states in learning the current resource. It also shows a history of learning resources used, and encourages the learners to reflect on their learning processes. The right window displays a list that puts learning resources in order of priority for recommendation.

3.3 Procedure

Let us next explain how to decide the order of priority for recommending learning resources to be learned next. It corresponds to deciding which resource indexes should be given priority.

3.3.1 Ordering with Knowledge States

(1) Case of Impasse
When learners reach an impasse in a learning phase, learning resources, which could facilitate the previous learning phase, are first recommended so that they can resolve the impasse. The previous phase as index is accordingly given priority. On the other hand, the next phases are not given priority. Learning resources that have the same media/communication channels are also recommended since the learners may get confused with a change of media/communication channels in addition to the change of learning phase. The same media/communication channels as indexes are accordingly given priority. In case learners' knowledge state is in an impasse, therefore, learning resources that have the previous phase and the same media/communication channels as resource indexes are recommended as resources that are more instructive.

(2) Case of Completion
When learners complete learning in a learning phase, learning resources that have the next phase as index are first recommended so that they can further their knowledge. The next phase as index is accordingly given priority. The previous phases, on the other hand, are not given priority. The media/communication channels as indexes are given in the same way as the case of impasse. In case learners' knowledge state is in completion of learning, therefore, learning resources that have the next phase and the same media/communication channels as resource indexes are recommended as resources that are more instructive.

3.3.2 Ordering with Learners' Needs

In learning a resource, some learners may demand change of media/communication channels for the learning resource to be learned next. Regardless of learners' knowledge states, in this case, the same learning phase and different media/communication channels as indexes are given priority. The same media/communication channels are not given priority. Second, the different learning phases as indexes are not given priority according to learners' knowledge states. In case of impasse, the next phases are not given priority. In case of completion, the previous phases are not given priority. Learning resources that have the same phase and different media/communication channels as resource indexes are consequently recommended as resources that are more instructive. However, the way of ordering discussed in 3.3.1 is executed if learners reiterate learning in the same phase.

3.3.3 Calculation for Recommendation

Let us explain the way of calculation for ordering learning resources with an example. Learning resources are ordered with recommendation score, which is calculated every resource. Each learning resource has a number of HTL indexes. The recommendation score is calculated as follows. It is first scored ten points per learning phase index that is given priority, and is scored minus ten points per learning phase index that is not given priority. Next, it is scored one point per media/communication channel index that is given priority, and is scored minus one point per media/communication channel index that is not given priority. The larger the recommendation score is, the higher the priority of recommendation is.

Figure 4 shows an example of ordering five learning resources. In this example, a learner inputs "impasse" as his/her knowledge states in learning a resource. The learning resource has the "understanding" phase, "text only" media as HTL indexes. In this case, the accretion phase as index is given priority. The stabilization phase is not given priority. In addition, the "text only" media as indexes is given priority, while the other media/communication channels are not given priority. Therefore, the recommendation scores for the five learning resources calculated as shown in the right side of Figure 4. The learning resource that has the accretion phase and "text only" media as HTL indexes is recommended in the highest priority.

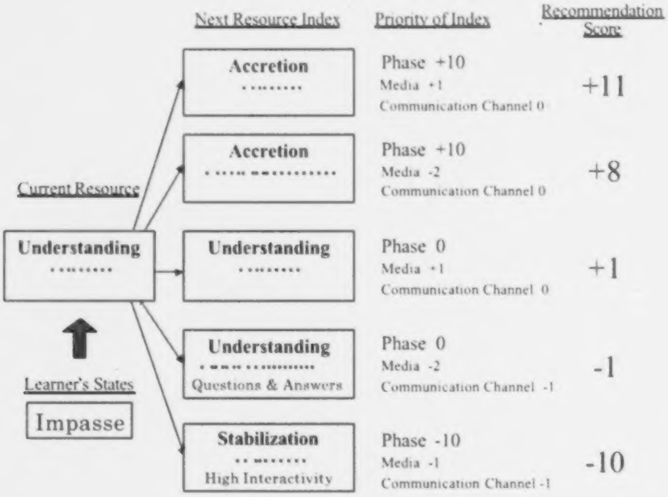

Next Resource Index
Priority of Index
Recommendation Score
Current Resource
Understanding
Learner's States
Impasse
Accretion
Phase +10
Media +1
Communication Channel 0
+11
Accretion
Phase +10
Media -2
Communication Channel 0
+8
Understanding
Phase 0
Media +1
Communication Channel 0
+1
Understanding
Questions & Answers
Phase 0
Media -2
Communication Channel -1
-1
Stabilization
High Interactivity
Phase -10
Media -1
Communication Channel -1
-10

Fig. 4 Example for Recommendation

4 Preliminary Evaluation

4.1 Experiment

In order to evaluate the adaptive navigation support with the resource indexes and the learning contexts, we have had a preliminary experiment. The main purpose of this experiment was to ascertain the validity of the way of calculation for the recommendation order.

In this experiment, we compared the order of priority for recommendation generated with the adaptive navigation support to the order in which subjects placed learning resources by reading them carefully. Table 2 shows learning resources used in the experiment, which are described about a learning topic of "Global Warming Issue". Subjects were 12 graduate and undergraduate students in department of engineering. In spite of a well-known topic, the results of pretest indicated that they did not necessarily have sufficient domain knowledge.

The procedure of the experiment with each subject was as follows:
(1) He/she was asked to learn the resource A and then to input his/her knowledge state after learning. If he/she wanted to change media/communication channels, he/she could also input it as his/her need.
(2) He/she was asked to read the remaining resources carefully and place them in the order where he/she felt them more proper for his/her knowledge state and need.

Table 3 shows the order of priority for recommendation in each learning context considered. The order is calculated by the way discussed in section 3.3. For example, the recommendation is done in order of resource C, B, D and E, when a subject's knowledge state is in completion. Comparing the order of priority for recommendation to the order that subjects decided, we evaluated the validity of the learning resource recommendation.

4.2 Result

Table 4 shows the results of this experiment. The vertical axis is the order in which the system placed the learning resources (System-decided Order for short) and the horizontal axis is the order in which subjects placed them (Subjects-decided Order for short). The smaller the number of the order is the higher the priority for recommendation is. Each value in the table means the number of cases that fulfilled the System-decided order and the Subjects-decided order. For example, there were six cases where both System-decided and Subjects-decided orders were the first place.

In order to look into an approximate tendency in Table 4, we divided the order of priority into High and Low. As shown in Table 5, the High order including the first and second places of both System-decided and Subjects-decided orders, and the Low order also including the third and fourth places. We then performed Fisher's exact probability test in Table 5. As a result, there was a significant relevancy between System-decided order and Subjects-decided order($p=0.00867$), and these orders were positively related with a correlation (ö=0.42). It indicates that System-decided order agreed with Subjects-decided order approximately.

Table 2 The Learning Resource for Experiment

	Resource	HTL Index
A	Think about global warming http://www.nature-n.com/g_wrm/index-j.htm	Phase : Accretion Media : Graphics
B	Eco-Life Guide • The Issue of Global Warming http://www.eic.or.jp/ecolife/t001.html	Phase : Understanding, Stabilization Media : Graphics, Others Communication Channel : Questions
C	Kyoto-Earth's Homepage • Environment• Global Warming http://www.pref.kyoto.jp/intro/21cent/kankyo/h3.html	Phase : Accretion, Understanding Media : Graphics, E-Mail
D	Global Warming http://www.wnn.or.jp/wnn-eco/cop3/index.html	Phase : Accretion, Understanding, S Media : Graphics, Others Communication Channel : Questions High Interactiv
E	Tackling to the global environmental problems • Global Warming http://www.epcc.pref.osaka.jp/apec/jpn/earth/index.htm	Phase : Accretion Media : Graphics

Table 3 Order of Priority that the System Ordered

Case of Completion

Resource	Priority			Or
	Phase	Media	CC	
B	+1	+1,-1	-1	
C	+1	+1,-1	0	
D	+1	+1,-1	-1,-1	
E	0	+1	0	

Case of Impasse

Resource	Priority			Or
	Phase	Media	CC	
B	-1,-1	+1,-1	-1	
C	-1	+1,-1	0	
D	-1,-1	+1,-1	-1,-1	
E	0	+1	0	

Case of Change (State : Completion)

Resource	Priority			Or
	Phase	Media	CC	
B	0	+1,-1	+1	
C	+1	+1,-1	0	
D	+1	+1,-1	+1,+1	
E	+1	-1	0	

Case of Change (State : Impasse)

Resource	Priority			Or
	Phase	Media	CC	
B	-1,-1	+1,-1	+1	
C	+1,-1	+1,-1	0	
D	+1,-1,-1	+1,-1	+1,+1	
E	+1	-1	0	

(CC : Communication Channel)

Table 4 Result of Experiment

System-decided Order	Subjects-decided Order			
	1	2	3	4
4	2	1	4	5
3	1	3	3	5
2	3	3	4	2
1	6	5	1	0

Table 5 Result of Experiment

	Subjects-decided HighOrder	Subjects-decided LowOrder
System-decided LowOrder	7	17
System-decided HighOrder	17	7

5 Discussion

From the results of the experiment, we have made sure that the adaptive navigation support is useful for learners to learn a certain topic with diverse learning resources. However, it does not work well for learners who cannot input their knowledge states and needs by themselves because these are important information for the adaptation. One way to resolve this is that teachers/instructors help such learners input. In addition, some learners may input their wrong knowledge states. However, this is not a serious problem from a whole learning process point of view since inputting "completion" as knowledge state despite his/her incompleteness of learning would cause a serious impasse in the next learning phase, for example. Alternatively, inputting "impasse" despite his/her completeness of learning as knowledge state would cause a complete learning in the previous phase without difficulty.

Lets us next discuss the adaptive navigation support compared with related work on courseware generation on the Web [8]. Courseware is generally generated in order to facilitate learning of a series of topics and relationships between these topics. Each topic included in a courseware accordingly needs to be designed as learning resource from a specific point of view. In related work on courseware generation, the same designer prepares each learning resource for each topic on the Web. However, it is hard to make a courseware from existing web-base resources since they are usually designed from different points of view. On the other hand, we focus on properly using diverse resources with the same topic, not with related topics, to promote learning of it from diverse points of view.

6 Conclusions

This paper has proposed a learning resource database that reorganizes learning resources on the Web with resource indexes. This paper has also presented the adaptive navigation with the database, which recommends learners some resources to be learned next according to their needs and knowledge states. This allows learners to use existing learning resources with a certain topic to promote their learning. In addition, the paper preliminarily evaluated the adaptive navigation support. In this experiment, we compared the order of priority for recommendation generated with the adaptive navigation support to the order in which subjects placed learning resources. As a results, we have made sure that it is valid.

In the future, it is necessary to evaluate the adaptive navigation support in more detail. We would also like to develop a more practical system and open to the public.

Acknowledgments

This research is supported in part by International Commuication Foundation, and in part by The Telecommunications Advancement Foundation.

References

[1] Brusilovsky, P., "Methods and Techniques of Adaptive Hypermedia", Journal of User Modeling and User-Adapted Interaction, 6, 87-129, (1996).
[2] Conklin, J., "Hypertext: An Introduction and Survey", Computer 20, 9, 17-41, (1988).
[3] Eklund, J., "Cognitive models for structuring hypermedia and implications for learning from the world-wide web", Proc. of The First Australian WorldWideWeb Conference (AusWeb95), http://www.scu.edu.au/sponsored/ausweb/ausweb95/papers/hypertext/eklund/index.html, (1995).
[4] Hasegawa, S., Kashihara, A. and Toyoda, J., "A Framework for Estimating Usefulness of Educational Hypermedia", Proc. of World Conference on Artificial Intelligence in Education (AIED-99), pp.711-713, (1999).
[5] Hasegawa, S., Kashihara, A., and Toyoda, J., "Estimating Design Scenario of Educational Hypermedia on WWW", Proc. Of 7th International Conference on Computers in Education (ICCE 99), Vol. 2, 229-236, (1999).
[6] Kashihara, A., Kinshuk, Oppermann, R., Rashev, R., & Simm, H., "An Exploration Space Control as Intelligent Assistance in Enabling Systems", Proc. of International Conference on Computers in Education '97, 114-121, (1997).
[7] Kashihara, A., and Toyoda, J., "Report on Experiences of Telelearning in Japan", Informatik Forum, Wien, Vol.12, No.1, 39-44, (1998).
[8] Vassileva, J., "Dynamic Course Generation on the WWW", Artificial Intelligence in Education IOS Press, 498-505, (1997)

An Analysis of the Practice of Web-based Learning In Elementary Schools In Taiwan

Jyh-Jong Chiou and Chao-Chen Yang
Department of Information Management Chaoyang University of Technology
168, GiFeng E. Rd., WuFeng, Taichung County, Taiwan 413, ROC
cjjbin@ms43.hinet.net, ccyang@mail.cyut.edu.tw

Advances in computer technology and the Internet with the prevalence of World Wide Web have provided alternatives and changes to our learning styles. We start by discussing the advantages and disadvantages of Web-based learning and the environment, then move on to assess the possibility of applying Web-based learning in elementary schools. The restrictions of computer-assisted learning and distance learning due to the environment and students' capabilities will then be discussed proceeded by its potential problems and solutions. Finally, we will discuss about the model and application of Web-based learning and the future researches. Hopefully, this will be of value to promote Web-based learning in computer classes in elementary schools.

Keywords: **Web-based, Web-based Learning, Distance Education, Distance Learning**

1 Introduction

Between 1998-1999, the computer learning community of Taiwan elementary schools has also changed rapidly. The Ministry of Education has invested 6.4 billion NT in a year furnishing facilities of computer labs in all the elementary schools, and each school is connected to the ADSL net line [1]. This revolutionary act has motivated and enhanced the web-based learning environment in schools.

WWW (World Wide Web) has definitely made great influence to our Web-based learning community. The variety and multiplicity of multi-media from the WWW has created a vivacious opportunity and environment for learners. Through the participation of teachers' posting their teaching materials on the web page, more interactions of teacher and student involvement in web-based learning can be anticipated, which will also be of tremendous help to the expansion of web-based learning in elementary schools. In this paper we will discuss the practice of Web-based learning in elementary schools in Taiwan, and to analyze its advantages and problems.

2 The Advantages of Web-based Learning

2.1 Learning not limited to space:

What used to restrict students in the classroom for learning is no longer a compulsive rule. Learning can be anywhere at any time, whether it is life-long learning for adults or a basic course for kids, as long as you have a computer and are able to get hooked to the Internet, you can surf and search all over the world for information through endless Websites. This new model of learning will definitely impose great challenge and influence on the old traditional learning. In the meantime, Web Paged curriculums provide much more flexibility for students to practice and review their lessons wherever and whenever they want, as long as facility allows. Through numerous Websites all over the world, knowledge and information are observed, exchanged, selected, and discussed among various counterparts. Finally, the concluding of data constructs the knowledge we want.

2.2 Web-based courses are easy to use in distance learning:

The amount of investment in Web-based courses is much less than investment in courses transmitted at Real-Time or Course-on-Demand. For the previous mentioned classes, fine equipment and hardware are required---the case where limitation comes for elementary schools. As for creating web pages, web-sites, and even integrating different means of multi-media, it of smoother manage to elementary schools especially in terms of finance and personnel; besides, the alterations and updating of the information on the teacher' s web-site provides flexibility to the course. Therefore, with the above considerations, there is obviously much room for expansion of web-based learning in elementary schools.

3 Problems of Web-based Learning in Elementary Schools

3.1 Lack of motivation for pursuing knowledge:

Web-based learning is learner-centered and self-directed. It is for learners of high motivation to inspire oneself with massive acquirement and achievement of information. The learner can also find his own way of solving problems and evaluate himself at the end. However, students of the elementary level are young at age and at most times, they depend on parents and teachers to set up their learning habits. It will certainly take more time and effort (to use web-based learning) if not enough self-imposed and active learning are involved. Therefore, it is most important to come up with a method that will stimulate the students' motivation for learning, and perhaps help them form active learning habits.

3.2 Lack of the ability for interchanges among students:

Interactions that occur during the process of web-based learning are usually carried out by means of E-mail, Questions List, News, and even NetMeeting. These may be challenging to elementary kids with the possibility of inferior typing skills or expressing ability. It is then quite necessary to provide special pre-courses as a prerequisite for this learning model and assist the students to obtain the needed skills step by step.

With the overwhelming amount of information available on the Internet, it is rather difficult for children to choose the data they want. It is necessary to have a guardian in assistance to lead them on the right track.

4 Analysis of Applying Web-based Learning to Elementary Schools

4.1 From the view of hardware:

By 1999, all the elementary and junior high schools in all 21 counties of Taiwan have been set up with access to the Internet web-sites [4]. In my opinion, the setting up of Web Server and the supply of relevant curriculums do not appear as a problem; however, the ban-width would be of a more complex issue. The unsymmetrical feature (downloading 1.54Mbps and uploading 384K) of ADSL lines in elementary schools may cause insufficient band-width while delivering data to clients at the remote end, when students accessing the courses on the same time.

At the elementary school where I work (a school in the suburb), about 30%-40% of the students have a computer at home, however, this does not imply direct access with the Internet. This could be the main obstacle for Web-based learning. The "rush hours" for Internet traffic jam occurs at the time when most people are at home which is about from5:00pm to 10:00pm, also the causing the problem of insufficient ban-width. With a 56K modem, this will probably be the most challenging factor of all.

4.2 The Position of Web-based Learning and Its Problems:

Certain computer skills must be required (browsing, downloading, printing out..) as a prerequisite for this type of learning, including means of turning in assignments and on-line examinations. Web-based learning is not just about browsing around, for then it would be merely fragments of learning. It should offer as an alternative channel of learning with careful guidance from parents and teachers.

As mentioned before, elementary children are still immature at mind and at heart, therefore, if Web-based learning is placed as assisted courses with gradual increase with the grade level, it is an opening of another interface to learning. Web-based learning is not suggested for replacement of interactive activities, personal involvement, personality molding, etc. According to my opinion, Web-based learning should be used as assisted teaching which provides another channel for learning.

5 Web-based Learning in Elementary Schools and the Prospects

5.1 About Interface of the Web and Courses Designing:

Vivid images and perhaps merry sounds and music can be attracting to children. It is only when children are attracted and motivated that learning takes place.

Not all courses are suitable for Web-based learning. Physical Education and sports could not be applied on the Internet, thus selective elements are involved in syllabus planning.

Web-based learning is mostly questioned by its lack of interactions. If courses can be designed to increase the interchanges as in real situations, through synthesis of images and sounds, bulletin boards, then the problem of unreality can be reduced. Designs of various types of interfaces is the goal and as for teacher-student interactions, Web-based E-mail, Web-based Chat Room, Questions List, News, IRC are all highly suggested means.

5.2 Objective Environmental Changes:

The construction of Wide Band-width Networks is no longer an impossible task. With the prevalence of ADSL, ISDN, Cable Modem, Direct PC, etc., prices are sure to be lowered. The successful case by SingAREN (Singapore Advanced Research and Education Network) using ADSL & Cable Modem can be a learning sample [2]. With proper combination of the cable TV and the Cable Modem, plus other means like ADSL, Web-based learning can definitely be activated into good use. As long as heavy traffic can be prevented in the Internet, anyone can roam around carelessly in the world of Internet for knowledge; for the Internet is a treasure island with endless sources of information.

6 Conclusions

The educational environments will be the use of highly interactive computing and communication in the future. Web-based learning gives us the chance to reflect on the traditional way of learning; it is not meant to replace the former learning style, but rather to provide an alternative learning model. Computers and network technology have potential not only to support learning for understanding in the classroom, but also to facilitate active guided professional development for teacher [3]. As long as we can have enough band-width, more flexible classes in school, more multiple teaching strategies and models, and assist each student according to his or her individual needs and ability, Web-based learning can certainly be anticipated to be the best tool for in our life-long learning.

References

[1] Chang, S. Y., "The Achievement of Plan in Basic Information Education in 1999", Ministry of Education Computer Center Newsletter, Vol 8810, pp. 1-8, (1999).

[2] Lek-Heng Ngoh, Francis S.C. Yeoh, Manjeet Singh, "SingAREN: The Singapore Advanced Research and Education Network", IEEE Communication Magazine, November 1998, pp. 74-82, (1998).

[3] Martha Stone Wiske, "Teaching for Understanding with Networked Technology", International Conference The Design and Application of Networked Learning Environments for Elementary and Junior High School, Tainan, Taiwan, January 6-7, pp. 28-43, (2000).

[4] Ministry of Education, http://www.edu.tw/information/expand/exestone/exp_summary.html (accessed on April 1, 2000)

An Effectiveness Study of Web-based Application for Mailing List Summary and Review

Satoru FUJITANI* and Kanji AKAHORI**
**Mejiro University College.*
4-31-1, Naka-ochiai, Shinjuku, Tokyo 161-8539 Japan
Tel: +81-3-5996-3127 Fax: +81-3-5996-3125
E-mail: fujitani@mejiro.ac.jp
***The Center for Research and Development of Educational Technology,*
Tokyo Institute of Technology.
2-12-1, O-okayama, Meguro, Tokyo 152-8552 Japan
Tel: +81-3-5734-3233 Fax: +81-3-5734-2995
E-mail: akahori@ak.cradle.titech.ac.jp

This paper reports an effectiveness research of e-mail discussion review support system with summary extraction method. The support system we have developed can automatically extract summary sentences from the normal conversational style language in e-mail messages using reference relationship of e-mails that participants have discussed. One could use the summary sentences for looking back on discussion, and use them as an idea database at a glance. Japanese natural language processing technology has been applied in the proposed method. In order to evaluate the effectiveness of the system, we conducted experiments using a questionnaire and protocol analysis. We compared the two system; the system with and without summary sentences in the table of e-mail content. As a result, following fact-findings were obtained. The system with summary sentences could promote reading strategy such as utilization of table of contents and comprehension of e-mail message structures. On the other hand, the system without summary sentence makes the reader pay attention to the detail information such as name of discussing member.
Finally, we concluded that the system with summary sentence is effective for understanding of relationship among various e-mail messages.

Keywords: **Mailing lists, Natural language processing, Distance learning, Learning environment, Summary sentence extraction, Collaborative learning, Factor analysis, Reading strategies**

1 Introduction

Collaborative learning support environments for network-based discussion appear to be investigated quite often [1][2]. For instance, e-mail is extensively used in the classes for learners' communication.

The research topic we reported here is collaboration support tools that intended for e-mail discussion. For the purpose of sharing of participants' activities on computer networks, we have proposed a summary extraction method along the development of mailing list discussions and an outline presentation tool for mailing list [3][4][7][9]. Japanese morphemes analysis system [8] is applied in our researches. This web-based tool supports reviewing the past discussion on the mailing list. As for results of the summary extraction method, we conducted comparative evaluation between the result of human summarization and of the method. The result suggests that the proposed method can detect major sentences in e-mail articles properly [4].

There is a number of preceding researches on the keyword and summary sentences extraction methods of documents [5][6][15]. But the most of extraction methods in preceding researches applied to well-documented text, like the newspaper manuscript or research paper. On the other hand, this research targets on the conversational style language in text form. For identifying the outline of e-mail discussion, there are many difficult problems in e-mail messages. These are:

- E-mail messages are conversational style language and many summary extraction methods using syntactic information could be not applied.
- The title of e-mail might not be changed as the discussion continues, if so, the title is not meaningful as the summary of documents.
- The method should identify the flow of discussion corresponding with e-mails in order to grasp the topic.

Besides, most of evaluation experiments in summary extraction method with natural language processing technology focus on the validity of algorithm, like adaptability or reproducibility. About analysis of reading comprehension when additional information, e.g. summary, is given, we could refer Ausubel's research on the advanced organizer model [10]. The paucity of reports on sentence comprehension process encouraged us to investigate it.

The purpose of the present paper is to analyze how the summary sentences accomplishes to an actual comprehension process. In this paper we describe an experimental study of e-mail message reading process with or without the extracted summary sentences.

In the first experiment, we investigated e-mail message reading strategies using responses of questionnaire. We conducted comprehension test and reading process analysis. In the reading process analysis, the result was divided into seven factors using factor analysis. The system with summary sentences could promote reading strategy such as utilization of table of contents and comprehension of e-mail message structures. On the other hand, the system without summary sentence makes the reader give attention to the detail information such as names of participating members.

In the second experiment, we analyzed peer discussion processes while reading e-mails on the World Wide Web (WWW) interface. We conducted the comprehension test of the e-mail messages. We also conducted protocol analysis of e-mail reading comprehension. Also hereupon, we compared the results with two conditions, one is a group to which the summary sentence of the e-mail messages was given, and the other is a group without summary sentence of e-mail messages. The results of protocol analysis show some difference in the number of utterance collected during the experiment.

2 Summary extraction method along development of discussion

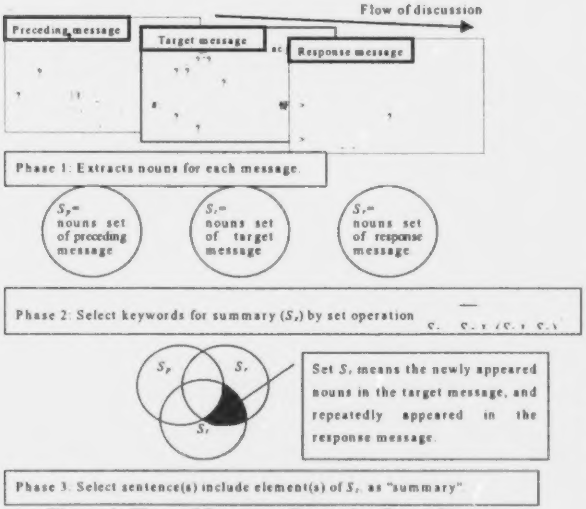

Flow of discussion
Preceding message
Target message
Response message
Phase 1: Extracts nouns for each message.
S_p= nouns set of preceding message
S_t= nouns set of target message
S_r= nouns set of response message
Phase 2: Select keywords for summary (S_s) by set operation
S_p
S_t
S_r
Set S_s means the newly appeared nouns in the target message, and repeatedly appeared in the response message.
Phase 3: Select sentence(s) include element(s) of S_s as "summary"

Figure 1: Flow of Summary Extraction Procedure from the target message.

The summary extraction method was discussed in our preceding research [3][4]. In this paper, we de-scribe the outline of the extraction method for better understanding by the readers.

2.1 Idea of the extraction method

We tried the extraction of keywords and summary sentences of the discussion from the document in the mailing list based on the preceding research [11] intended for the discussion such as Netnews. This key-word extraction method can be used in the discussion environment with the following features; (1) The change in the topic does not take place easily in a row. (2) There is a habitual practice that the participants do repeated revisions during the discussion, and uses the quotation appropriately. But although it is limited in our case, e-mail discussion might develop in many ways, and the topic is changeable. The relationship of e-mail message for the keyword extraction between the target message and the past messages is little in e-mail discussion.

Then, in this paper, we set up a hypothesis: Although there was a dependency on the topic, e-mail messages with new information are tempted to encourage responses later. That is, we can treat them as topic making messages in the mailing list. We proposed a summary extraction method that enables pick up those new information as keywords and summary sentences in the messages [3][4]. Figure 1 shows flow of keyword and summary extraction by this method from the content of the message of the mailing list.

However, this summary extraction method supposes both preceding and response messages must be consecutive in the thread. Therefore, we set some assumptions for these exceptions. When the target message is the beginning message in the thread, the title of the message is also used and extracts common nouns among the title of the target message and the body of related messages. On the other hand, when the target message is the last message in the thread, we choose keywords only from the preceding and the target message, and common nouns in both messages is treated as keywords for the target message. Moreover, summary sentences are regenerated when there is a new message in the mailing list.

2.2 Summary generation and WWW display tool

We implemented summary generation and display tool using the proposed summary extraction method. This can be operated on the World Wide Web (WWW) to refer to past messages of mailing list [7]. Fig-ure 2 shows the display of Web page with and without summary sentences. These Web pages fulfill the role of table of contents (TOC) of mailing list. Readers look for contents from the list view with tree structure along continuity of e-mails. They can trace the body of each message from Web link. TOC shows serial number, writer, date of issue, and the title of the e-mail. In Figure 2(b), under the link to the body, summary sentence obtained by the noun set is displayed. When more than one sentence is extracted by the method, it becomes so complicated that the implication of TOC is diminished. So we referred to the procedure widely used in full-text search system [6], the number of displayed sentence is trimmed off to only one sentence that include maximum different number of chosen keywords. We treat that sentence as important sentence for TOC.

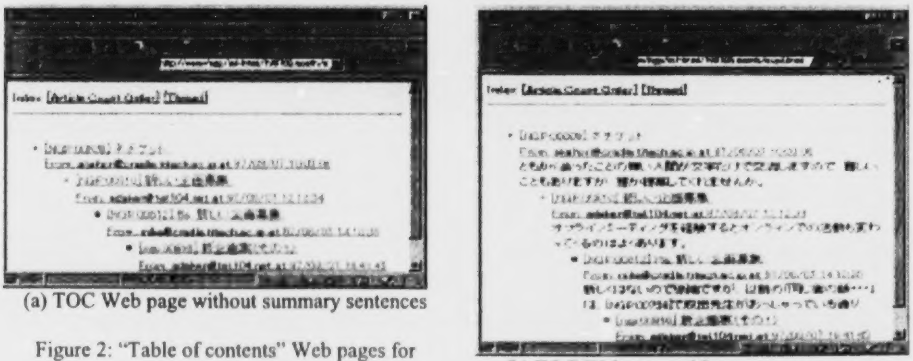
3 Evaluation experiment in the e-mail message comprehension

In this research, we carried out the evaluation experiment on effects of summary presentation while reading past e-mails on the mailing list. We conducted reading comprehension test and factor analysis of reading strategies.

3.1 Methods

3.1.1 Subsubsections

In the experiment, we made the settings resembling the actual Web-based environment of the mailing list.

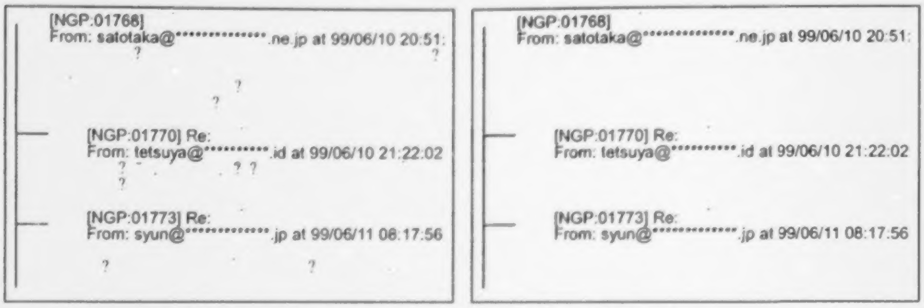


(a) TOC Web page without summary sentences

(b) TOC Web page with summary sentences.

Figure 2: "Table of contents" Web pages for review.

We printed out the several e-mail messages in a row, referred to as "thread", and the table of contents (TOC) for the e-mail messages in addition. Figure 3 shows the part of the experimental materials. To the semblance of Figure 2, the summary is generated from the proposed summary extraction method. It appeared in parallel beneath each entry in the TOC, or not appeared. E-mail messages for the summary extraction method consist of nine messages of mailing lists. The topic in the mailing list is the educational use of the Internet for foreign Japanese schools and domestic schools.



[NGP:01768]
From: satotaka@**************.ne.jp at 99/06/10 20:51:
? ?
?
?

[NGP:01770] Re:
From: tetsuya@**********.id at 99/06/10 21:22:02
? ? ?
?

[NGP:01773] Re:
From: syun@*************.jp at 99/06/11 08:17:56
? ?

[NGP:01768]
From: satotaka@**************.ne.jp at 99/06/10 20:51:

[NGP:01770] Re:
From: tetsuya@**********.id at 99/06/10 21:22:02

[NGP:01773] Re:
From: syun@*************.jp at 99/06/11 08:17:56

(a) Printed TOC with summary sentences.
(b) Printed TOC without summary sentences.

Figure 3: The part of the printed experimental materials

3.1.2 Procedures

Subjects of the experiment are 56 undergraduate students. None of the subjects know about the mailing list. The printed TOC as described above is affixed in front of the e-mail messages. The printed experi-mental materials were distributed to the subjects, and the researcher explained the experimental setting: "We are going to try to read past e-mails, and catch up with the exchange of the e-mail discussion." In addition, the participants were asked to use TOC positively.

The subjects read these documents for eight minutes. After the eight minutes, the researcher confirmed all the subjects had read the documents once. After that, the subjects were not allowed to read the docu-ments again, and they did the e-mail comprehension test. They had answered the following questions:
1. Write down the name of places which had appeared on the first e-mail as much as you remember.
2. Write down the episode of the first e-mail as much as you remember.
Later, they answered a questionnaire, which was consisting of 28 items with five-point rating scale and space for writing comments. The items were concerning the e-mail reading strategies. In order to make questionnaire, we referred the preceding research about sentence intelligibility [12] and our preceding researches.

3.1.3 Experimental Design

The factor of the experiment materials is presence of summary sentences in the TOC. We can divide the subjects into two levels. 56 subjects were randomly assigned to both two experimental settings of the materials, and were divided into the two groups of 28. Therefore, it is a between-subject experimental design with one factor.

3.2 Results

3.2.1 The comprehension test

In the question 1: "the name of places which had appeared in first e-mail", we compared the numbers of correct answers between two groups. We leave non-response persons off from the analysis. As a result of ANOVA, there was no significant difference in the number of correct answers

Table 1: Extracted factors and results of ANOVA

Name	Ratio	
1. Read the content in detail and memorize	21.5%	**p<.01
2. Use Table of Contents	10.5%	*p<.05
3. Think about the development of discussion	8.7%	
4. Combine their knowledge	7.1%	
5. Think about the theme of discussion	5.1%	
6. Read back and force	4.3%	
7. Write down a memo	3.9%	
Accumulated Explanation Ratio	61.1%	

(F(1,48)=1.065, p>.10).

In the question 2: "the episode of the first e-mail", we have chosen eight words from the message as answer words of the question beforehand. We compared the numbers of appeared answer words between two groups. We also leave non-response persons off from the analysis. As a result of ANOVA, there was no significant difference in the average number of the answer words (F(1,48)=.415, p>.10).

Table 2: ANOVA for Factor Scores

(a) ANOVA for Factor Score of factor 1.

Source	SS	df	MS	F	R^2
Factor	5.61	1	5.61	7.21	0.0098**
Error	38.11	49	0.78		
Total	43.72	50			

**p<.0

(b) ANOVA for Factor Score of factor 2.

Source	SS	df	MS	F	R^2
Factor	4.62	1	4.62	5.99	0.0180*
Error	37.78	49	0.77		
Total	42.39	50			

*p<.0

3.2.2 E-mail reading strategies

The factor analysis with major factor method and varimax rotation method was applied to the 28 questionnaire items concerning strategies of the comprehension for e-mail messages.

As we shown in Table 1, we sequentially named the seven factors. We extracted these factors from the change in the eigenvalue. The accumulated factor explanation ratio was 61.1%. Next, factor score of seven factors was calculated par subjects.

Table 2 shows results of ANOVA. As a result of ANOVA for seven factors, a significant difference was found in the first factor "Read the content in detail and memorize" (F(1,50) =7.212, p<.01) and the second factor "Use Table of Contents" (F(1,50)=5.988, p<.05).

In addition, we compare the score for each item in two groups.

As a result, the group with summary sentences could promote reading strategies such as "Usefully reading TOC help me to know the content of sentences" (t(51)=3.58, p<.01), and "Refer TOC to read the content in the messages" (t(52)=2.76, p<.01). Those who use summary sentences would have tendency that they try to know the relation between the content and the whole structure of the thread.

On the other hand, the group without summary sentences would take reading strategies such as "Pay attention to the participant's name or the name of places appeared on the e-mail while reading" (t(50)=2.34,p<.05), "Read the content carefully and memorize in detail" (t(51)=1.94, p<.10). Thus, they attempted to give attention to the detail information such as names of discussing members.

3.3 Summary of the experiment

In the experiment, there was a significant difference in the e-mail reading strategies while there was no significant difference in the recognition of e-mail contents. Our proposed method is a kind of new information presentation method for the support of e-mail reference. We might say our summary extraction method and display tool for mailing list could help readers to suppress consideration of detail information in the documents. On the other hand, these supports help to maintain the particular contents easier.

4 Protocol analysis of e-mail reading process

From the suggestion in the preceding section, adding summary sentences possibly provide a hint on the e-mail reading strategies. In this section, we examined changes of e-mail reading strategies when having the benefit of summary sentences using protocol analysis. To put it concretely, the subjects answer questions after reading the content of e-mail messages that is displayed on the WWW pages. We have observed the e-mail reading strategies while participants were reading e-mail messages.

4.1. Methods

4.1.1 Experimental materials

We have used 43 e-mail messages of the mailing list for the summary extraction method. Educational use of the Internet in foreign Japanese schools and domestic schools was focused in this mailing list.

Each e-mail message can be traced back and forth from TOC WWW page shown in Figure 2. We have set two conditions; one was in which summary sentences were given, and the other was in which it was not given.

4.1.2 Subjects

Subjects were 20 undergraduate students forming ten pairs. The reason for making group of two is that the subjects could discuss naturally with each other, and therefore, we could collect natural speech proto-cols easily from the conversation [13][14]. They were randomly assigned to two different experimental settings as described previously in this paper.

4.1.3 Procedure of the experiment

The two subjects were seated in front of the computer and were given an instruction for the present experiment by researcher. After the e-mail reading, the subjects were asked to answer some questions on reading comprehension. The subjects were allowed to start reading e-mail messages from anywhere. Then, they read e-mail messages through WWW pages for 20 minutes. After that, they were asked to answer some questions regarding particular content in the e-mail messages within 15 minutes. Finally, they were interviewed about the provision of advance information of the mailing list and the interest on the topic of discussion. None of the subjects know about this mailing list.

4.2. Analysis and Results

In this experiment, we recorded peer protocol with a digital video (DV). Then, we played the recordings and type in the conversation by listening the recordings. During the analysis of utterance, we identify sev-eral reading strategies or procedure for sentence comprehension. For each unit of procedure and strategy, the protocol was classified into the protocol categories [13]. For the classification, we have used the result of the factor analysis as we seen in Table 1. The categories "Read the content in detail and memorize" and "Use Table of Contents" were found to be significantly different on factor analysis. In the first cate-gory, we have considered utterances if the subjects read particular personal name and place name aloud. In the second category, we have considered utterances if the subjects read aloud the summary sentences or pursue continuity of the mailing list by pointing to the TOC. Some subjects pointed using mouse cur-sor's move or their fingers.

Table 3: Frequency of strategies appearance between two categories

Protocol category	With summary	Without summary
1. Read the content in detail and memorize	128	103
2. Use Table of Contents	35	22

Table 3 shows the comparative result with two protocol categories. As the number of subjects is very less, a clear conclusion could not be drawn. But as in Table 3, the frequency of category 1 was relatively higher than that of category 2. As a the result, by means of summary display tool with e-mail messages has been suggested as a method to manage a lot of reading strategies easily. However, though the differ-ence of the frequency does not contradict the results of ANOVA in the previous section, it does not show a significant difference in the comparison of ratios ($\chi^2(1) = 0.67, p > .10$).

In this experiment, a significant difference was not seen in the frequency of the e-mail reading strate-gies. We need to add the number of experiments as well as study the influence of experimental design in peer conversation.

5 Conclusions

The results of this research may be summarized as follows:

1. We applied the summary extraction method for mailing list, and analyzed e-mail reading comprehen-sion and reading strategies for reference. Although the result is limited to the e-mail messages we used, the display of e-mail summary sentences affects experimental subjects' reading strategies. On the other hand,

the result of comprehension test does not show significant differences. We may con-clude at this point that the method of summary sentence extraction is effective in understandings of relationship of e-mail messages.

2. The influence of summary display on the e-mail reading strategies was examined from the analysis of utterance protocol. The use of Table of Contents WWW page along with e-mail summary sentences does not make a difference in the frequency of utterances, but preferential trend for the use of e-mail summary sentences was observed.

As a problem yet to be solved in the future, we are interested in examining the effectiveness of reading strategies when e-mail messages are posted and read in real time.

Acknowledgement

Our special thanks are due to Madhumita Bhattacharya, Ph.D., the National Institute of Education, Singapore, for reading the manuscript and making a number of helpful suggestions.

References

[1] Kusunoki, F. & Sayeki, Y., "We can learn because of the opinions different each other", Journal of Information Processing Society of Japan, Vol. 40, No. 6, pp. 564-568, (1999).

[2] Inaba, A. & Okamoto, T., "The Network Discussion Supporting System Embedded Computer Coordinator at the Distributed Places", Educational Technology Research, Vol. 18, Nos. 1-2, pp. 17-24, (1995).

[3] Fujitani, S. & Akahori, K., "A Summary Sentence Extraction Method for Web-based Mailing List Review Application and Its Effectiveness Study", Advanced Research in Computers and Communications in Education (ICCE99), G. Cumming et al. (Eds.), IOS Press, Vol. 1, pp. 327-334, (1999).

[4] Fujitani, S. & Akahori, K., "A Summary Sentence Extraction Method of E-mail Discussion and Its Web-based Application to Mailing List Review", Educational Technology Research, Vol.23, Nos. 1-2, *In printing*, (2000).

[5] Sasaki, I., Masuyama, S. & Naito, S., "Proposal on sentence extract method which pays attention to vocabulary coherency", Technical Report of Information Processing Society of Japan, 93-NL-98, pp. 65-72, (1993).

[6] Sumita, K., Tomono, T., Ono, K. & Miike, S., "Generation of Automatic abstract with document structural analysis, evaluations as retrieval presentation function", Journal of The Institute of Electronics, Information and Communication Engineers, D-II, Vol. 78-J, No. 3, pp. 511-519, (1995).

[7] Fujitani, S. & Akahori, K., "Improvement of content summary extraction method along with development of discussion about document of mailing list summary system", Proceedings of 14th annual conference of Japan Society of Educational Technology, 2pB02-3, pp. 691-692, (1998).

[8] Kurohashi, S. & Nagao, M., "Japanese morpheme analysis system "JUMAN" version 3.61", Graduate school of information science, Kyoto University, (1999).

[9] Ken'ichi Fukamachi, "fml" Mailing List Server Package, http://www.sapporo.iij.ad.jp/staff/fukachan/fml/index-e.html (accessed on August 1, 2000).

[10] Ikeda, S. & Tanaka, S., "improvements of experiment diagram in preceding organizer research", Reading sciences, Vol. 29, No. 2, pp. 41-55, (1985).

[11] Ishihara, M. & Akahori, K., "Developments of discussion summary system for discussion support with problem", Journal of Japan Society of Educational Technology, Vol. 22, No. 1, pp. 1-12, (1998).

[12] Uchida, N., "Is the sentence understanding process "top down" or "bottom up?" ": In Shun-ichi Maruno, some controversies in cognitive psychology, Kyoto: Nakanishiya publication, pp. 165-188, (1998).

[13] Kaiho, H. & Harada, E., "Introduction of protocol analysis", Tokyo: Shin-yo-sha, pp. 118-134, (1993).

[14] Madhumita, & Akahori, K., "An Evaluation Method for Audiovisual Software Based on Protocol Analysis", Media and Education, Vol. 1, pp. 19-27, (1998).

[15] Firmin, T. & Chrzanowski, M. J., "An Evaluation of Automatic Text Summarization Systems, Advances in Automatic Text Summarization", The MIT Press, pp. 325-336, (1999).

An Intelligent On-Line Learning System by Combining Assessment and Adaptive Learning

Wan-I Lee* and Bih-Yaw Shih**
** Department of Information Management, Shu-Te University, Yen-Chau, Kaohsiung County, Taiwan, E-Mail• Wilee@mail.stu.edu.tw*
** * Department of Management Information System, Yung Ta Institute of Technology & Commerce, Pin-Tung, Taiwan, E-Mail• Byshih@mail.ytit.edu.tw*

The purpose of this research is the development of an intelligent on-line learning system by combining assessment and adaptive learning to each individual student. It includes two major tasks: (1) Provide different types of students with the most adequate context when he/she is doing on-line geometry learning activity on a university level via the Would Wide Web (WWW); (2) Identify changes in students' van Hiele levels of geometry thought after taking an on-line geometry course. In the research, the Van Hiele Geometry Test developed by Usiskin[11] was first administered to all students to determine their knowledge of geometry as described by Van Hiele[12]. A student's level of geometric thought was identified only by his/her responses to the pretest. Next, different contexts of instruction were selected depending on a student's level. Meanwhile, the on-line assessment of each unit will be performed after he/she completes one learning unit. Also, the results of the assessment are stored as the personal profile in the database and used to generate adaptive learning materials of instruction for the next unit. Finally, when the student completes all materials of a topic, the student is post-tested using the same Van Hiele Geometry Test to identify changes in the student's van Hiele level of geometry thought after taking the on-line geometry course.

Keywords: **On-line learning system, Assessment, Adaptive learning, WWW, Van Hiele Geometry test, Geometric thought**

1 Introduction

Students are usually required to understand the units of a topic assigned by their teacher without concern for individuals' backgrounds in that field. Also, the learning topic is limited to the teachers' subjective thoughts and the schools' policies. Therefore, students cannot choose individual topics, which could increase their interest and improve their performance. Meanwhile, students use the time-consuming way to present their learning knowledge through written papers. This process causes some of the students could not catch up, and they may give up during the semester. If a student does not connect current knowledge with prior knowledge, then improving his/her knowledge can be very difficult.

The technology of the Internet has developed dramatically. Now a day, the Internet and the WWW have proven to be useful tools for improving communications between the instructors and students because of its use of multi-media, short response time, and etc. Therefore, the on-line learning system is a helpful tool to enhance an individual's motivation and learning process. However, an on-line learning system within the context cannot adequately apply to all individuals without understanding their general achievement in the studies. There are many researchers focusing on how to develop adequate on-line lectures to enhance individuals' learning interest, and improve their motivation [1][2][4][5][6]. However, if the on-line lecture cannot be applied to each individual depending on his/her learning performance, ability, and feed back, the effectiveness of the on-line learning will be dramatically reduced. Few studies have applied on-line pre and post tests to identify which learning contexts are more effective for an individual and examined his/her learning performance during the learning processes.

The van Hiele model of geometric thought successfully describes a student' s understanding in geometry. The van Hiele model consists of five levels of reasoning: visual, descriptive/analytic, abstract/relational, formal logical, and rigor [15]. The VHL has been used to judge students' abilities in doing geometric problems. If students are below level III, they are generally unable to construct proofs by themselves. Many researchers [3][4][7][8][10][16] found that student' s reasoning abilities and van Hiele levels were related to their proof-writing abilities. Senk reported that students in level IV or level V have the ability to complete mathematical proof problems [8]. Students in level IV have the ability to construct proofs by themselves and not just memorize the proof processes. Therefore, if there are any on-line learning system which could provide the individualized learning material depending on the results of on-line pre-test, assessment, and post-test, the system will be a great contribution in the field of computer assisted learning.

In the following section, the concept of the research model will be described, the on-line Van Hiele geometry test will be explained, the generation of adaptive learning materials will be discussed, and the on-line assessment will be explained.

2 The Concept of the Model

The on-line learning system proposed in the research integrates the pre-test, post-test, assessment and the adaptive learning materials. The pre-test is used to determine the ability of a student before he/she starts the unit of the on-line learning topic. After the student finishes the learning of the unit, the assessment test is given to evaluate the performance of his/her study. This process is repeated until all units of the topic are tested. Finally, the post-test is given to evaluate the performance of a student after he/she has finished all units of the topic. Meanwhile, these records are stored in the database of the users' profiles for the generation of adaptive learning materials. Therefore, adaptive learning materials could be generated based on the records of students' profiles, and their on-line learning performance could be dramatically improved. The concept of the model is illustrated schematically in Figure 1.

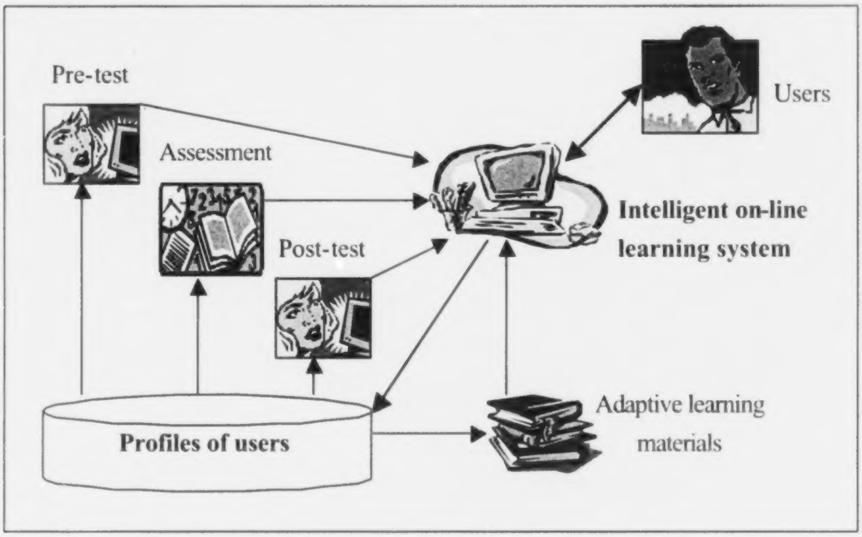


Figure 1. Schematic representation of the model of on-line learning system

3 On-Line Van Hiele Geometry Test

In 1959, P. H. van Hiele, a teacher in the Netherlands, reported on studies that he and his wife, Dina van Hiele-Geldof, had conducted dealing with mental development in geometry [4][13][14][16]. The van Hieles identified five different and unique levels of geometric thinking. These levels have been scaled in two different ways: from I to V and from zero to IV. Senk pointed out that all results and references from the van Hieles' studies described on the zero through IV scale have been translated to the I through V scale [9]. In this study, the I to V scales were used because students who have not attained the basic or ground VHL could be assigned a 0 rank [9].

Senk's five levels of development in geometry are listed below:

Level I: Visual
Students recognize geometric shapes based on their visual transformations from their images of these geometric shapes. Students are not aware of the properties of these shapes.

Level II: Descriptive/analytic
Students accurately describe the properties of shapes by observing, measuring, and drawing a model. For example, students at this level would be able to recognize that a rhombus has all sides congruent.

Level III: Abstract/relational
Students can verify figures hierarchically by analyzing the properties of figures. For example, students at this level would be able to recognize that a square is a rectangle.

Level IV: Formal logical
Students can understand the meaning of proof in the context of definitions, axioms, and theorems. For example, students would be able to show that the parallel postulate implies that the angle sum of a triangle is equal to 180°.

Level V: Rigor
Students are able to establish consistency of set axioms and can compare axiomatic systems (e.g., Euclidean and non-Euclidean geometry). For example, students would be able to verify the existence of parallelograms and angles between parallel lines in non-Euclidean geometry.

Using observation data, the van Hieles conjectured several properties that govern the five levels of thinking as students learn geometric ideas. These properties are: (a) individual exploration and reflection on geometric concepts are needed in order to move from one level to another level; (b) one cannot engage in thinking at a higher level without passing though the lower levels; (c) each level has its own language, linguistic development notations, and symbols; and (d) the learning process in each level does not overlap with previous levels.

The van Hiele Geometry Test (VHGT) was scored using the scoring procedures identified by [11] in his report on VHL for the Cognitive Development and Assessment Association (CDASS) Development and Achievement in the Secondary School Geometry Project. The CDASS developed a total of 25 questions to measure students' geometry skills. These questions were used to determine the students' understanding of geometric concepts as identified by [12]. Students were given 35 minutes to complete the test. There were five questions on the VHGT for each VHL, as illustrated in Table 3.

Students were assigned weighted scores for each VHL based on whether their responses met a predetermined criterion on each subset of the test. A score for a student was assigned based on criteria in Table 1.

1 point for meeting criterion on items 1 to 5 (Level I)
2 points for meeting criterion on items 6 to 10 (Level II)
4 points for meeting criterion on items 11 to 15 (Level III)
8 points for meeting criterion on items 16 to 20 (Level IV)
16 points for meeting criterion on items 21 to 25 (Level V)

Items	Measure a student's ability to
1 ~5	Recognize geometric shapes based on an individual's visual abilities.
6 ~10	Measure properties of geometric shapes by observing and drawing a picture.
11~15	Verify figures, hierarchically, by analyzing the properties of figures.
16~20	Understand proof meaning in the context of definitions, axiom, and theorems.
21~25	Identify the consistency of set axioms and compare axiomatic systems.

Table 1: Summary of Properties of the van Hiele Geometric Test

A student had to correctly answer at least three of five questions in order to meet the criterion. Each VHL corresponds to a weighted sum from the weighted sum scores assigned for each subset of items on the VHGT. According to the van Hiele levels of geometric thought, a student who attains at least level IV would be able to write original proofs. For example, suppose a student has the following results: 3 correct out of 5 questions in level I; 4 correct out of 5 questions in level II;2 correct out of 5 questions in level III; 4 correct out of 5 questions in level IV; 2 correct out of 5 questions in level V. This means, for level I, the student received one point. For level II, the student received two points. For level III, the student received zero points. For level IV, the student received eight points. For level V, the student received zero points. This produces a total of 1 + 2+ 8 =11 points. Students must satisfy the criterion at level n and all preceding levels to be considered for level n. This result indicated that the student' s geometry level was not in level IV or V because the student could not skip level III, which, according to the test, the student had not attained. In this case, the student' s geometry competency thought was evaluated as VHL II.

4 Generation of Adaptive Learning Material

The adaptive learning material is generated according to the user' s profile stored in the database. Because this research focuses on the development of an on-line learning system for a geometry course at the university level, therefore, the way of categorizing the geometry materials is explained in this section. When a student starts to learn geometry, he/she develops geometric knowledge from the basic concept of point, line, to space. Each of these concepts is involved in one-dimension, two-dimension, three-dimension, and extra. Therefore, the methodology of categorizing the geometry materials is based on this learning process and its basic concept map is presented in Figure 2.

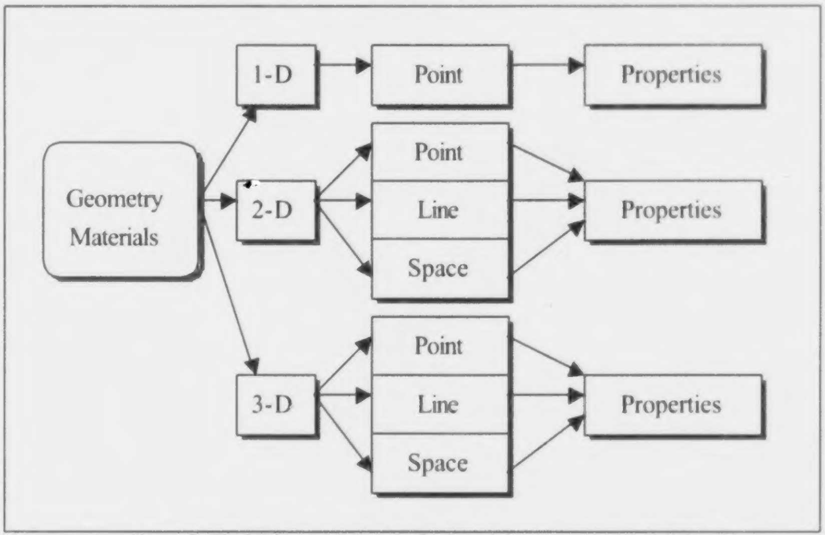


Figure 2: The basic concept map of categorizing geometry materials

5 On-Line Assessment

When an individual completes one learning unit via the on-line learning system, the On-Line Assessment (OLA) of each unit will be performed. All of the testing is multiple-choices questions which involved conjecture of proof processes that consist of one of the five answers given. The result of the assessment is used to selected materials of instruction for the next unit.

The OLA, based on ideas from Yerushalmy[17], was designed by the researchers was used to ascertain the learning style of each student. OLA used a scale from zero to four to rate the ability to analyze an individual student' s conjecture of proof processes. For each question, maximum possible OLA score was four. The rating scales used for this OLA are presented in Table 2.

0---No argument is correct.
1---Gives a few arguments, but these are not sufficient to solve the problem.
2---Quotes a related theorem and connects it to the approach.
3---Clearly supports statements in the argument, but there may be minor errors or gaps.
4---Constructs a complete proof.

Table 2: On-Line Assessment Rating Scale

As mentioned earlier, OLA rating score was designed by the researcher and determined to be reliable. Cohen' s Kappa is used to assess investigators agreement when the data are nominal categories and Kappa should be high usually greater than 0.7 (Morgan & Griego, 1998). The reliability coefficient using SPSS for Windows (v 8.0) was high (Cohen' s Kappa raters for OLA was 0.83).

6 Conclusions

Learning assessment is an important process during learning education but most of the research focus on the computer-based learning world such as implementation of traditional instructions or tests on the Internet, adaptive assessment by the allocation of on-line testing questions, development of virtual classrooms for improving students' learning performance, and etc. However, very little research has been conducted to develop on-line learning system by combining assessment and adaptive learning. This study has successfully proposed a credible and modularized methodology for developing an intelligent on line learning system by combining assessment and adaptive learning for each student.

OLA is particularly important for most students because many teachers may not consider an individual student' s background for conducting adaptive instruction and assessment for their students. It is known that many students consistently misinterpret procedures they learn in the classroom. For each on-line user, the OLA system will record and report the mistakes on each learning unit. It will help students identify his/her learning difficulties. As the learning difficulties of each learner are considered in the OLA system, a more adaptive, efficient, and profile-based learning environment will be conducted.

Reference

[1] Baker, P. G. & Benest, I. D., (1999). The on-line lecture concept-a comparison of two approaches. Printed and Published by the IEEE, Savoy Place, London WC2R OBL, UK.
[2] Bjedov, G., (1995). Utilizing the World Wide Web and the Internet to facilitate learning in large classes. Proceedings of the Frontiers in Education Conference.
[3] Frerking, B. G., (1994). Conjecture and proof-writing in dynami9c geometry. (Doctoral dissertation, Georgia State University, 1994). Dissertation Abstracts International, 55/12, 3772.
[4] Hoffer, A. R., (1981). Geometry is more than proof. The Mathematics Teacher, 74, 11-21.
[5] Martin, P. T., (1996). Email and the Internet as a teaching tool: A critical perspective. Proceedings of the Frontiers in Education Conference.
[6] Nicolaidis, M., (1997). On-line testing for VLSI. Printed and Published by the IEEE, 0-7083-4209-7.
[7] Senk, S. L., (1982). Achievement in writing geometry proofs. American Educational Research Association. New York, NY. (ERIC Document Reproduction Service No. ED 218 091)
[8] Senk, S. L., (1983). Proof-writing achievement and van Hiele levels among secondary school geometry students. Unpublished doctoral dissertation, University of Chicago, Chicago.
[9] Senk, S. L., (1989). Van Hiele levels and achievement in writing geometry proofs. Journal for Research in Mathematics Education, 20(3), 309-321.
[10] Stover, N. F., (1990). An exploration of students' reasoning ability and van Hiele levels as correlates of proof-writing achievement in geometry (Doctoral dissertation, University of Oregon, 1989). Dissertation Abstracts International, 51.
[11] Usiskin, Z. P., (1982). Van Hiele levels and achievement in secondary school geometry (Final Report of the cognitive Development and Achievement in Secondary School Geometry Project). Chicago, IL: University of Chicago, Department of Education. (ERIC Reproduction Service No. DE 220 288)
[12] Van Hiele, P. M., & van Hiele-Geldof, D., (1958). A method of initiation into geometry. In H. Freudenthal (Ed.), Report on methods of initiation into geometry (p.67-80). Groningen: J. B. Wolters.
[13] Van Hiele, P. M., (1959). Development and learning process, a study of some aspects of Piaget' s

psychology in relation with the didactics of mathematics. Groningen, the Netherlands: J. B. Wolters.

[14] Van Hiele, P. M., (1974). System separation and transfer. Educational Studies in Mathematics, 5(4), 413-417.

[15] Van Hiele, P. M., (1986). Structure and insight: A theory of mathematics education. Orlando, FL: Academic Press.

[16] Wriszup, I., (1976). Breakthriughs in the psychology of learning and teaching mathematics. In space and geometry. Columbus, OH: ERIC/SMEAC, 75-97.

[17] Yerushalmy, M., (1987). Introduction and generalization: An experiment in teaching and learning high school geometry (Doctoral Dissertation, Harvard University). Ann Arbor, MI: University Microfilms, Inc.

An on-line ITS for elementary algebra

Li Yi-Ping*, Chan Kan-Kan**

University of Macau
P.O.Box 3001, Macau
Tel: 853-3974323
Fax: 861095
*fstypl@umac.mo , **fedrc@umac.mo

The objective of this research is to reinforce the concepts and procedures of elementary algebra that students learn in junior schools. Students react to teacher's instructions in various way. However, in a traditional class, the ratio of teacher to student is still too great. The question of how to help all the students with limited number of teachers arises. This paper describes how to achieve the above objective with the help of an intelligent tutoring system. It discusses the design outline and the system architecture of the proposed system. The tutor tracks student's performance and uses this information to provide most suitable instruction to each student dynamically.

Keywords: **Web-based learning environment, intelligent tutoring system, elementary algebra**

1. Introduction

In a class of forty students, it is hard for teachers serving every student's questions within a class of forty minutes. Teachers teach students concepts and methods or techniques to solve problems in group. Then related exercises are given to students to practice at home. Students who have no doubts in class might cope with the exercise and learn well while some might not master the technique that teacher has taught. They always frustrate when they cannot solve the problem. In this situation, some advice from teacher is very helpful in their learning process. However, teachers are not always available while they need help. Also teachers might not be able to answer many students' doubts at the same time. This research is conducted with the aim of using computers to support the knowledge acquisition process that is adjusted to the capabilities of individual student. Students just need to have a web browser to connect to school network and would get assistance right away.

Many existing CAI applications do help a bit in students' learning process but they do not consider the background knowledge of students. This means that they might provide inappropriate feedback to students which in turn affects student's progress in learning. In order to overcome this situation, research has been investigated on intelligent tutoring system which includes functions for guiding students towards proper knowledge acquisition, according to observation of the student's problem-solving process and identification of the causes of student error.

We first depict the learning environment of our system in section 2and then the overall architecture of our system is mentioned with detail description of main components of ITS in section 3. The final section concludes our work.

2. Learning Environment of on-line ITS for elementary algebra

ITS for elementary algebra is designed as a problem solving environment to be used in class. Therefore we assume that student is familiar with the basic concepts of elementary algebra and know the ways to factorize a polynomial. Students use the system as a tool at home or during class practice. Since the condition that students use it lacks teacher's support, an interactive problem support should be built into the system. With this feature, students might get help on steps of problem solving where he has difficulty.

In order to access the on-line tutoring system, a student just needs a web browser and types the address where the system locates. An instance of the system will be created in student's computer in the form of ActiveX control. Although it might argue that there is great network delay in loading the system in student's computer, interactivity and userfrindliness deserve a short delay. In fact, in a local environment, the network traffic is not so congested. Therefore this is not a real problem. Instead, students can use it as if any Windows program and do not have to worry about its maintenance or compatibility issues. The control serves as a communicator betweent the system and the student. It transfers student's action to the system and returns the reponse of the tutor to the student.

Every student has his own session during the learning process. When a student enters the system with his user name and ID, a model of student performance is created or opened to set his learning environment. ITS selects a problem according to student's level for him to work or waits for the student to enter a problem which he has doubts. In both situations, the student solves it with the guidance of the tutor in a step-by-step way. The system keeps track of every step of the student in background. If nothing goes wrong, it remains quiet otherwise it prompts student's error. His problem solving procedure is kept in the system for future reference.

3. Overview of on-line ITS for elementary algebra

Our system follows the standard architecture of client-server model. The system resides on the server side. The basic components of the learning system are the domain module, pedagogical module, student modeler and the interface.

The domain expert module consists of two main programs. One is a problem solver which is capable of solving problems in its knowledge base. The other one is question generator that creates new problems according to the instruction of pedagogical module. In order to achieve its mission, the knowledge base is composed of both rules and cases. The expert model is capable of solving general problems by the rules coded in its module. As for miscellaneous problems, they are indexed as cases with problem characteristics and solving techniques so that the domain expert knows how to retrieve the relevant solving technique with the detected problem features.

The domain that we have chosen is factorization of algebraic polynomial for students in elementary classes. Given a polynomial, factorization is to express an integral polynomial as a product of prime polynomial. Therefore a polynomial is not completely factored unless each factor is either a monomial or a prime integral polynomial. Generally, there are 4 basic methods to factorize an algebraic formula. They are: (1) obtaining the common factor (2) using identities (3) cross-method and (4) divide the polynomial into groups and then simplify groups to find factors.

The pedagogical goal is to let junior students master the methods to factorize a polynomial smoothly. Students are taught the basic method to factorize an algebraic formula. However, they always get lost in the actual application to find the factors of a given formula. Therefore, we have organized the pedagogical knowledge by constructing groups of problems according to the level of difficulty, problem characteristics and solving technique. Within each level, there are pre-requisite question types which a student must understand before a certain question type will be generated. Figure 1 shows part of the relation among question types. There are several groups having polynomial problems as bellows:

- Problems, which just need one method to solve. They are polynomial with common factors, problems that satisfies the characteristics of perfect square: $(a \pm b)^2 = a^2 \pm 2ab + b^2$, difference of 2 squares: $a^2 - b^2 = (a+b)(a-b)$, sum or difference of 2 cubes: $a^3 \pm b^3 = (a \pm b)(a^2 \mp ab + b^2)$, or perfect cube: $(a \pm b)^3 = a^3 \pm 3a^2b + 3ab^2 \pm b^3$ and problems of trinomials with a degree of 2 i.e. $x^2 + (a+b)x + ab = (x+a)(x+b)$
- Problems that need 2 methods to solve are posed, for example: $ab^2 - 4a$. There are a few combination of solving techniques like common factor with standard equation, common factor with cross method or cross method with standard equation.
- Problems with more than 4 terms that need to be divided into groups of terms before they can be solved by the general methods.
- Problems that require special techniques to solve like adding terms, splitting terms etc.

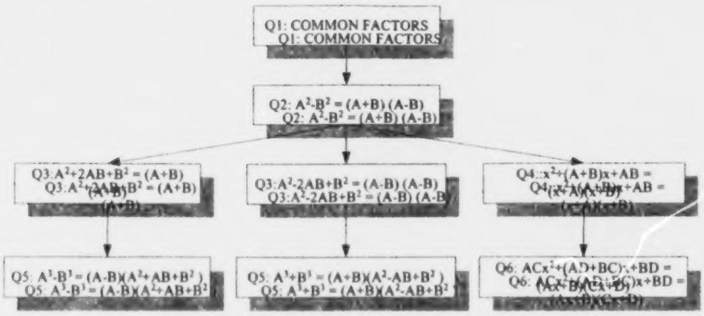

Q1: COMMON FACTORS
Q2: A^2-B^2 = (A+B) (A-B)
Q3:A^2+2AB+B^2 = (A+B) (A+B)
Q3:A^2-2AB+B^2 = (A-B) (A-B)
Q4: x^2+(A+B)x+AB = (x+A)(x+B)
Q5: A^3-B^3 = (A-B)(A^2+AB+B^2)
Q5: A^3+B^3 = (A+B)(A^2-AB+B^2)
Q6: ACx^2+(AD+BC)x+BD = (Ax+B)(Cx+D)

Figure 1. Part of the pedagogical knowledge

A student modeler tries to understand the mental state of a student so as to provide a more accurate estimation of individualized instruction. The task of building a student model is extremely difficult as the amount of information to capture is huge. Although it has been pointed out that this task is intractable[1], an incomplete student model is still very useful in the process of tutoring [2] [3].

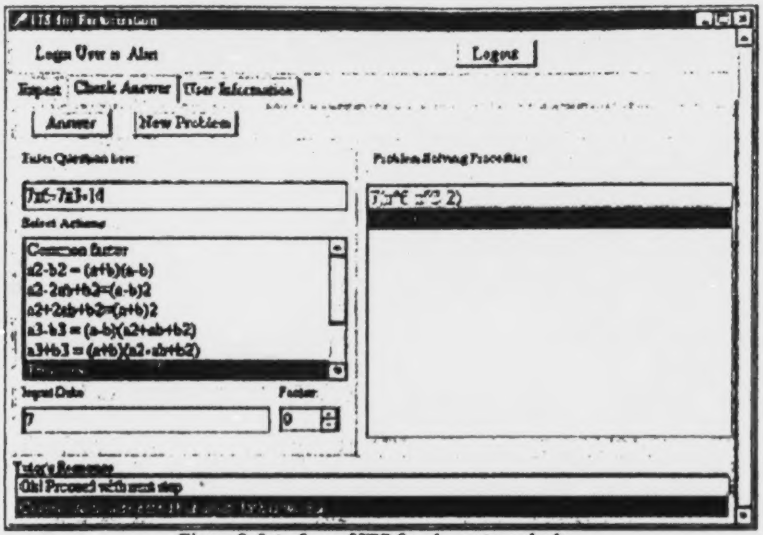
The student modeler evaluates the solution of the student and the ways he factorizes the polynomial with respect to the one solved by domain expert. Although the solution path for a given problem of a student might be different from that of domain expert, the student's solution is still correct if it answers to the problem. In our case, if all the factors that the student found are irreducible, his answer is correct. The tutor would suggest him another way to solve the problem if it is found that his solution path is different. In this way, students are guided to know that there is always another way or a better method to solve a problem. Referred to table 1, student is asked to factorize a problem $4a^2$-$16b^2$, the second column shows the ways that he solves the problem. The student answers the question correctly and his student model is updated accordingly. Although his problem solving procedure differs from the sample, this would not affect his student model. Only the tutor would suggest him its way for the student as reference.

Problem: $4a^2$-$16b^2$			
Student	Reason	Tutor	Reason
=(2a-4b)(2a+4b)	a^2-b^2=(a+b)(a-b)	=4(a^2-$4b^2$)	Common factor
=2(a-2b)2(a+2b)	Common factor	=4(a+2b)(a-2b)	a^2-b^2=(a+b)(a-b)
=4(a-2b)(a+2b)	Multiply numbers		

Table 1. Procedure that the student and the tutor solves a problem.

The student model in ITS for elementary algebra contains a general information about the student, history of student's performance such as previously solved problem, information about the usage of factorization techniques and what kind of problems he is able to solve according to the pedagogical knowledge. All these information is important to allow students to receive more instruction and perform more problem-solving questions in areas in which they are relatively weak. An array of integer is used to keep the system's belief of student's mastery of a certain skill.

The interface of our system shown in Figure 2 is designed to be user friendly. It is divided into 3 main regions: upper part shows "Check answer" and "New problem" buttons; lower part is the area where the tutor provides feedback. The student interacts with the system mainly at the left side of middle part of interface. He may enter a question by himself or the system might generate one based on his experience. A list of actions is listed for him to explore the problem solving technique. He may select an action to tell the system how he would solve the problem. Every action selected would be given an appropriate feedback to the student. In this way, he might discover what is the consequence of selecting an action. An input area is allocated for the student to enter auxiliary data needed for his selected action. When the answer button is clicked, the student's solution is evaluated and his student model is updated accordingly.


ITS for Factorization
Login User is Alan
Logout
Expert
Check Answer
User Information
Answer
New Problem
Enter Question here
Problem Solving Procedure
Select Actions
Common factor
a2-b2 = (a+b)(a-b)
a2-2ab+b2=(a-b)2
a2+2ab+b2=(a+b)2
a3-b3 = (a-b)(a2+ab+b2)
a3+b3 = (a+b)(a2-ab+b2)
Input Data
Factor
Tutor's Response

7x6-7x3-14

7

0

Ok! Proceed with next step

Figure 2. Interface of ITS for elementary algebra

3.1 Evaluation

In our experiments to simulate the problem solving procedure of students using the system, we found that it follows the overall design. It is able to provide individualized instruction, appropriate feedback and model student's performance. For major types of the factorization problem in junior school, the tutor is able to solve and guide the students. However, there are also questions that it fails to solve and guide. There are also cases that the available action for students to use in the problem solving process is not enough.

4. Conclusion

In this paper we have described an on-line intelligent system with interactive problem solving support and curriculum sequencing. A prototype system designed with some learning theory is implemented. The system helps students to reinforce the factorization technique. Our intention of building this system is to increase the learning progress of students and it shows to be a successful tool according to informal evaluation

Since the success of an ITS depends greatly on the student model, we are planning to improve our system with a more accurate student model in the near future. The user interface will be reconstructed to improve the interactivity between users and the system. The implemented domain knowledge is quite limited in this stage and we are developing larger domain knowledge.

Reference

[1] Self J., "Bypassing the intractable problem of student modeling", Intelligent tutoring system: at the Crossroads of Artificial Intelligence and Education, (1990).

[2] Self J., "Formal Approaches to Student Modeling", Student Modeling: The key to individualized knowledge-based instruction, (1994).

[3] Woolf B.P. and Murray T., "Using Machine Learning to advise a student model", Student Modeling: The key to individualized knowledge-based instruction, (1994).

Anatomy On The Cutting Edge: Pre-Dissection Lecture-On-Demand At The National University Of Singapore

J.A. Gilles Doiron
Centre for Development of Teaching & Learning, National University of Singapore
10 Kent Ridge Crescent, Singapore 119260
Tel: (65) 874 - 2529
Fax: (65) 777 - 0342
Email: doiron@nus.edu.sg

The NUS Integrated Virtual Learning Environment (IVLE) was developed so that staff and students could use this information technology infrastructure to communicate, exchange documents and information, discuss, chat, and access custom learning materials and course related web sites. IVLE also enabled the university to consider new pedagogical approaches, which would utilise its campus-wide broadband access to meet specific teaching and learning needs. A "lecture-on-demand" (LoD) delivery was seen as a viable tool that would allow students to take more responsibility for their learning and enable them to have greater control over their time schedule. With the collaboration of the Faculty of Medicine, the Centre for Instructional Technology and the Centre for Development of Teaching & Learning, a prototype anatomy pre-dissection LoD, "The Abdominal Wall & Inguinal Canal", was produced. This paper examines the design and development issues addressed in building this prototype. Field test data on the technical reliability, and ratings and comments from student feedback are also presented.

Keywords: **lecture-on-demand, LoD, web-based learning, streaming video, instructional technology**

1 Introduction

After decades of escalating computer use in all faculties, its impact on university teaching is still largely a promise. Although widespread computer use has brought about the development of interesting applications of computer technologies, such as the Integrated Virtual Learning Environment (IVLE) at NUS, the use of computers in the teaching and learning process is still not commonplace.

Some researchers have examined the adoption of computer assisted learning (CAL) technologies (Faseyitan, S. O., & Hirschbuhl, J., 1992) and the diffusion of computers into university teaching (Proulx, M., & Campbell, B. 1997). They note that virtually all faculties use computers, but as Larose et al (1999) points out, the integration of computers and pedagogy remains isolated and sparse, with its implementation depending greatly on the faculty.

With reference to the long-term implications of the integration of information and communication technologies (ICT) into the university fabric, there are of course differing opinions. Some believe that teaching will remain essentially traditional, with its neo-behaviourist epistemological standpoint in which information technologies simply take the place of print or the use of the chalkboard (Tapper, J., 1997). Others are convinced that ICT will, in itself, lead to profound changes in how teachers and students relate to knowledge. They follow the trend towards a "constructivistic" perspective in which the integration of ICT requires a global reconsideration of the university-level relationship to knowledge.

The prudent approach to implementing institutional change linked to information technology is echoed by those who caution us that the application of some aspects of ICT may go against what we have traditionally valued as good education. Beckett (1998) bemoans that higher education has been colonised by its servitude to new technology and that disembodied learning is a poor substitute for classroom teaching. Other researchers, such as DeKerckhove (1997), suggest that at present the inclusion of ICT in the teaching practice may do more harm than good, since most teachers have not been adequately trained to use them as an effectual teaching intervention.

At NUS, the IVLE provides the ICT infrastructure that enables the university to consider new computer mediated pedagogical approaches. Consequently, because lectures in auditoriums where class sizes are substantially large (two hundred or more) are viewed as not very conducive to learning, these lectures were considered as possible candidates for asynchronous web-based access. The time saved can be better-spent in small group discussion sessions where teaching staff and assistants can focus on getting the students to apply, discuss and reflect on subject matter that has been acquired independently from a pre-produced individually accessible web-based lecture. Thus a "Lecture-on-Demand" (LoD) approach was seen as a viable tool that would allow students to take more responsibility for their learning and enable them to have greater control over their time schedule.

2 Method

In April 1999, a professor of anatomy from the Faculty of Medicine expressed concern that his students were not as well prepared for the hands-on tasks of dissecting a cadaver. His lectures to an audience of over 200 students consisted of showing slides, describing the procedure to be undertaken and providing relevant information on the topic. He felt that his students would benefit from a well-produced instructional video made available prior to entering the dissection room. He wanted a delivery system that would enable each student to access the pre-dissection lecture at their own preferred time, and allow them to spend as much time as needed to view and review the content.

The Centre for Development of Teaching & Learning (CDTL) and the Centre for Instructional Technology (CIT) at NUS were consulted, and agreed to provided the design and the development expertise to build a prototype lecture-on-demand (LoD) web site. In addition to the content expert, the prototype development team would include a team leader/instructional designer, a multimedia producer, a graphic artist/programmer, a video crew, a video editor and assistance from system engineers and technicians for video conversion and computer server set-up.

The initial screen designs and flowcharts were produced and the structure of the content was established. The content was to be broken down into short segments arranged in the normal dissection sequence. Since the actual dissection procedure is a very long process, three cadavers were readied for the video explanation of the dissection. The lecture segments were taped simultaneously from two camera angles to provide the necessary perspectives.

After validation of the edited video, the transfer to a streamable digital format was investigated. The testing phase established that the transfer process required digitising the analogue video to a non-compressed raw AVI (Microsoft Audio/Video Interleave) digital format and then encoding it into an ASF (Microsoft Active Streaming Format) file format. The ASF format enables data to be sent out in "packets" across a network at a specific bandwith or bit rate. The NUS intranet infrastructure has enough bandwidth to accommodate the streaming of ASF files without, at most times, losing any packets. That is to say that at most times ASF video accessed from campus will run smoothly.

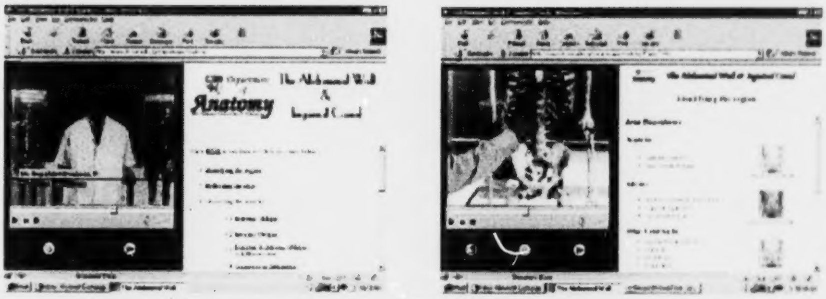


Figure 1. Web site screen shots of Home Page (left) and Topic Segment (right).

The site is programmed to run from either Netscape or Internet Explorer browsers. The screen layout shows three frames: the title frame, the text and graphic frame, and the video player frame (see Figure 1.). The program includes seventeen (17) video clips (40 min. total time) and fourteen (14) full screen graphics with pop-up labels. The final item in the home page selection is linked to an online quiz with multiple choice, fill-in-the-blank, and select-from-a-list type questions.

3 Discussion

A link to a feedback form was added to the site and seven questions, including two with text box input, were designed to examine what the students thought of the LoD approach. Access to the site was restricted to first year Faculty of Medicine students and first year Faculty of Dentistry students, and as of the 01 February 2000, sixty-one (61) students had submitted the online feedback form. The data collected so far is serving as preliminary data for formative evaluation. As the beta version will become available next semester, long before the students need to attend the dissection lab on this particular subject, more feedback will be collected. The following is a summary of the responses provided to date through the online feedback form.

Question #1: How do you rate this prototype program? Not Useful 1 / 2 / 3 / 4 / 5 Very Useful

	Tally	Percent
2.00	02	03.3%
3.00	07	11.5%
4.00	26	42.6%
5.00	26	42.6%
Total	61	100.0%

Question #2: Would you use this program to prepare for a dissection session? No/Yes

	Tally	Percent
No	04	06.6%
Yes	57	93.4%
Total	61	100.0%

Question #3: Would you use this program during a dissection session? No/Yes

	Tally	Percent
No	18	29.5%
Yes	43	70.5%
Total	61	100.0%

Question #4: What do you like most about this program?
The students typed their comments in the text box provided. Many indicated that they were pleased to access the lecture at their convenience. They also pointed out that they liked how the content was organised, the realism of

the video and the fact that they could replay and stop the action as they wished. Some wrote that the on-screen presence and explanations by their own professor of anatomy gave weight to the content. Here are some of the comments:

> "Whenever I'm unclear of a small point, I can easily rewind back and listen to it again, without interrupting a predissection talk that's held normally."..."I find it comprehensive and useful. More relevant than the usual pre-dissection lecture"..."The lesson is well-organised, and the video shows the real cadaver which aids understanding greatly. As a pre-dissection lecture, it is very good."..."I can access it anytime I want to review the dissection"..."I like the way it's presented. Actual cadaveric structures are shown to us instead of ideal Netter's pictures. Then we know what to look for in our cadavers. The website can also be accessed many times at our convenience to recollect things during dissection."

Question #5: What do you like least about this program?
The students typed their comments in the text box provided. Many indicated that they would have wanted access from their home. Other comments included problems getting access to university computers, some computers not set up for running the program, and poor quality audio. Here are some of the comments:
"Cannot access it from home. rather troublesome to use it in school since the com. lab is usu. occupied."..." clearity of the things lecturer is saying"..."Cannot access from COFM computers because they lack the video software."..."Can only be accessed successfully on campus, would be much more convenient if it can be accessed at home."

Question #6: Would you like to see more pre-dissection lectures done in this way? No/Yes

	Tally	Percent
No	03	04.9%
Yes	58	95.1%
Total	61	100.0%

Question #7: After going through this program do you feel less confident, or more confident about undertaking the dissection? Less confident/More Confident/No change

	Tally	Percent
Less Confident	01	01.6%
More Confident	54	88.5%
No Change	06	09.8%
Total	61	100.0%

4 Conclusion

During the development, testing and evaluation stages of this prototype, the feedback from the department of anatomy staff and students was very supportive. The experience enabled the development team to establish production guidelines and procedures, and to create a template web site for producing a complete series of anatomy LoDs.

In all, the project involved fifteen (15) individuals (4 Department of Anatomy, 9 CIT and 2 CDTL) who dedicated a total of approximately 1,000 man/hours to the project. Much was learned and can now be applied to reduce the development time of future anatomy LoDs. A reasonable estimate for producing another LoD with similar production requirements would be around 600 man/hours. The cost of production, based on supplying approximately 1,250 students (250 students per year for 5 years), would amount to less than one half man/hour per student.

The "Anatomy Pre-dissection" LoD prototype development is an example of a project making sound and pragmatic use of appropriate information technology tools to provide valuable learning experiences. However there is a need to continually examine and refine instructional design decisions so as to take advantage of new pathways to learning which are made possible through the creative use of ICT.

REFERENCES

[1] Beckett, David. (1998). Disembodied Learning: How Flexible Delivery Shoots Higher Education in the Foot, Well Sort of. Electronic Journal of Sociology: 3, 3.[iuicode: http://www.icaap.org/iuicode?100.3.3.2]

[2] Faseyitan, Sunday O., and John Hirschbuhl (1992) "Computers in University Instruction: What Are the Significant Variables That Influence Adoption?" Interactive Learning International, 8(3): 185-94.

[3] De Kerckhove, D. (1997). Connected Intelligence. Toronto: Somerville House Publishing.

[4] Larose, François David, Robert Dirand, Jean-Marie Karsenti, Thierry Grenon, Vincent Lafrance, Sylvain & Cantin, Judith. (1999). Information and Communication Technologies in University Teaching and in Teacher Education: Journey in a Major Québec University's Reality. Electronic Journal of Sociology: 4, 3.[iuicode: http://www.icaap.org/iuicode?100.4.3.3]

[5] Proulx, Michelle & Campbell, Brian. (1997). The Professional Practices of Faculty and the Diffusion of ComputerTechnologies in University Teaching. Electronic Journal of Sociology: 2, 3.[iuicode: http://www.icaap.org/iuicode?100.2.3.2]

[6] Tapper, J. (1997). Integrating Online Literacy into Undergraduate Education. Higher Education Research and Development, 16 (1), 25 - 40.

Automated Quantitative Extraction Method of Aesthetic Impression from Color Images using the Tone in the HLS Muncell Color Space

Toshinori Yamasaki, Tetsuo Hattori and Yukihiro Matsubara
Faculty of Engineering, Kagawa University
Hayashi-cho, Takamatsu, Kagawa 761-0396 Japan
Yamasaki (hattori, matsubar)@eng.kagawa-u.ac.jp

The students acquire a visual literacy through learning the coloring systematically in the fine arts subject. This paper describes an extraction method for the aesthetic impression of the paintings based on the tone in the Muncell color space for fine arts subject. The impression, which the human being gets from the paintings, depends on the motif, the composition and the coloring. Here, we discuss the evaluation method of the paintings by the computer based on the tone that includes the lightness (intensity) and the saturation (vividness). We perform the evaluation experiment of the paintings that have a unique coloring. The evaluation result approximately resembles the impression of which human being is moved. This method is also useful for retrieving the image database using the ambiguous key words like the impression words.

Keywords: **aesthetic impression of paintings, color tone, color harmony, visual literacy, fine arts subject, image retrieval system**

1 Introduction

Fine arts subject educates the ability of the sense beauty, that is, a visual literacy through recognizing a form and a color. For training such a visual literacy, it is important for the students to understand the nature of color systematically. Visual literacy that is the aesthetic judgment ability becomes the basis of the expression and the appreciation activity in the fine arts learning. The students acquire the visual literacy by experience through repeated practice of painting the picture. On the other hand, there are the empirical rules about the composition and the coloring in the art. As for the color harmony, Ostwald, Muncell and Moon Spencer are well known.

Recently, the multimedia database spreads widely with the development of the network technology. In the multimedia database retrieval, it is useful that we can refer database using the impression words and the ambiguous feeling words in addition to the key words. Recently, an image database retrieving by impression words as beautiful, balmy is reported [1-5].

We report the extraction way of the aesthetic impression degree of the paintings based on the Moon Spencer's color harmony theory [6]. However, in the Moon Spencer's way, we can estimate the degree of the beauty as the numerical value but we cam not know the detail impression like the dark, light, bracing impression which each painting gives. In this study, we describe more concretely the way of extraction the aesthetic impression of the paintings based on the tone in the HLS Muncell color space.

2 The tone and the systematic color names

We call a suitable coloring the color harmony. In the color harmony theory, Ostwald, Muncell and Moon Spencer are well known. Also, a color system is established by JIS (Japanese Industrial Standards) and

PCCS (the Japanese Color & Coloring System).

Here, we use the tone in the Muncell HLS space for estimating the impression of the paintings more precisely. We express a color by the word, which shows the impression of the color like the light green, the dark green. There is a difference between bright and dark, strong and gentle, vivid and muddy in the same color, same hue. We call this difference the tone (Lightness and Saturation). The tone is a concept of the lightness L and the saturation S being compounds and shows an impression of the color, which doesn't depend on the hue well. As the tone has an each image, it is easy to connect the tone the psychological effect of the color. We can evaluate the feeling impression of the paintings by extraction the tone from the image data. In this paper, we adopt the PCCS tone for evaluating the impression of the paintings [7]. The PCCS defines the tone in the lightness L and the saturation S in the Muncell color space and gives color system as the tone and the hue. The PCCS classifies into 12 kinds of tones in each hue and packs the same tone of the every hue. Figure 1 shows the classification of the tone.

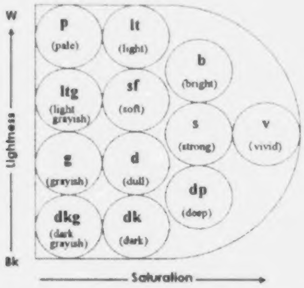


Figure 1 Tone (Lightness – Saturation)

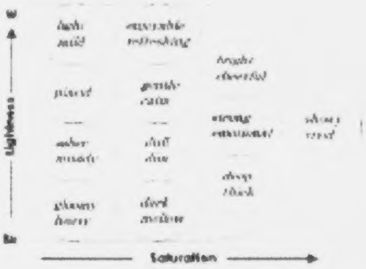


Figure 2 Systematic Color Names

The tone image is defined by the systematic color names in the PCCS color system. The systematic color names is the color expression way that gives a modifier according to each fundamental color like white, red and blue. It sets a way of combining a fundamental color name and modifier. The modifier in PCCS includes an adjective, which shows the hue difference like the tinge of red, green. On the contrary, it has no word, which shows only lightness or a saturation. The bright impression includes not only the high intensity but also the vivid saturation. The mild impression means the high lightness and low saturation. Figure 2 shows the systematic color names of the tone space.

3 Evaluation of the aesthetic impression

After getting the image data through the scanner, we extract the impression feature of the paintings. Figure 3 shows the outline of our method. The resolution and the size of the image data is 120 [pixels/inch] and 640*512 [pixels] respectively. The image data is a full color, bit map.

The image data has RGB color component and doesn't connect with the color sense of the human being straight. Also, it is difficult to adjust the color tone in the color synthesis. Here, we convert the RGB to the HLS value in the Muncell color space, which fits for the color sense of the human being. Mucell color system shows the color as the three components, H (Hue), L (Lightness) and S (Saturation) and is used widely in the coloring. Figure 4 shows the Muncell HLS color space. We get the H[0,360], L[0,1], S[0,1] values through the conversion of the RGB[0-255] value.

The number of the colors in the image data is enormous for processing data by a computer. Here, we reduce the number of colors to the degree, which doesn't loose the color tone of the paintings. We divide the H, L and S to 10 and 14 respectively.

Hue (H)	Lightness (L)	Saturation (S)
R	8.5	14
YR	9	13.5
Y	9	13
GY	9	12
G	8.5	11
BG	8.5	10
B	8.5	10
PB	8	11.5
P	8	11.5
RP	8.5	12.5

Table 1 Maximum Values of L, S

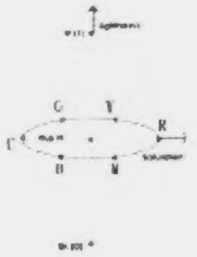


Figure 4 HLS
Muncell Color Space

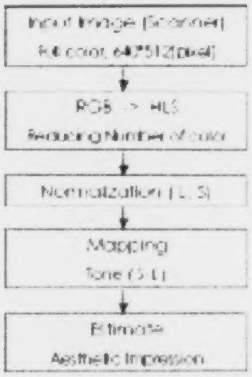


Figure 3 Outline of the
Extraction Process

The maximum value of the L and the S depends on the coloring material and each hue shown in table 1. Therefore, the value range of the L and S is different according to each hue. For example, the maximum L, S value of the Red and Purple hue is 8.5, 14.0 and 8.0, 11.5 respectively. Here, we normalize the L, S value 0-10 ranges.

From the above way, we estimate the number of the pixel in the S-L tone space through mapping the image data to the tone space. We can find the aesthetic impression of the paintings by estimating the position of the mapped pixel in the tone space because of the correspondence between the tone space and the impression modifier shown in figure 2. In this experiment, we evaluate the number of the colors, which accounts for 70 % of the color area. However, we cannot estimate the impression because the distribution in the tone space becomes apart. Here, we calculate one position of the tone space from several distributed positions using the weight coefficient of each tone position.

$S = W_i S_i$ $\qquad$ $L = W_i L_i$ $\qquad$ (1)

Where $W_i = \sum(a_i / \sum a_i)$ □a_i is the number of the occupied pixel in each color.

We estimate the impression of the paintings according to the tone index (S, L) defined in equation (1).

4 The evaluation experiment

The simple coloring picture is tested beforehand. As a result, the showy picture of the pure color and the gloomy picture are mapped over the v (vivid) and dkg (dark grayish) tone respectively. Typical paintings and poster works from renaissance to modern are tested in this experiment shown in table 2. Figure 5 and figure 6 shows examples of the paintings and the typical mapping result in the tone space respectively. We can evaluate the aesthetic impression of the paintings using figure 6 and figure 2. The extraction impression is listed as follows.

"Mona Lisa" (2) of Leonardo da Vinci is famous for gently smiling lady. This painting locates near dk (dark) in the tone and gives dark, mellow impression.

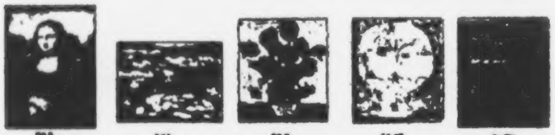
Monet's "Water Lily" (5) is said the mystic beauty of the surface of the water and is situated on the tone space near ltg (light grayish). We can say that the water lily has a cooled silent image.

Gogh's "Sun Flower" (8) is painted yellow strongly which he liked most. It is situated on the tone space near s (strong). From this result, we can evaluate that the impression of sunflower is strong, passionate painting.

Figure 7 shows the mapping result of the works in table 2. The above-mentioned results agree with the established reputation and the eye inspection of human being.

Table 2 Lists of Paintings and Design Pictures

	Painter	Style	Work	epoch
1	Leonardo da Vinci	Renaissance	Virgin of the Rock	1503
2	Leonardo da Vinci	Renaissance	Mona Lisa	1503
3	Rembrandt	Baroque	Night Watch	1642
4	Rembrandt	Baroque	Raising of the Cross	1633
5	Monet	Impressionist	Water Lilies	1903
6	Monet	Impressionist	Flower Pot	1903
7	Monet	Impressionist	Popies	1873
8	Gogh	Modern	Sun Flowers	1888
9	Gogh	Modern	Self Portrait	1889
10	Signac	Impressionist	Saint-Tropez	1900
11	Renoir	Impressionist	Theater Box	1874
12	Renoir	Impressionist	Les Grands Boulevard	1880
13	Renoir	Impressionist	La Liseuse	1876
14	Klee	Modern	Baldgreis(Senecio)	1922
15	Matisse	Modern	Green Stripe	1905
16	Matisse	Modern	Red Room	1947
17	Munch	Modern	Scream	1893
18	Munch	Modern	Sick Chiled	1895
19	Poster	Design	Star Wars	
20	Poster	Design	Bug's Life	



[2] Mona Lisa (Leonardo da Vinci) [5] Water Lily (Monet) [8] Sun Flower (Gogh) [14] Baldgreis (Klee) [17] Scream (Munch)

Figure 5 Examples of the paintings

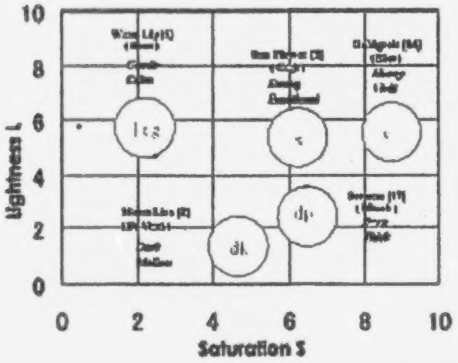


Figure 6 Mapping Result in the Tone (1)

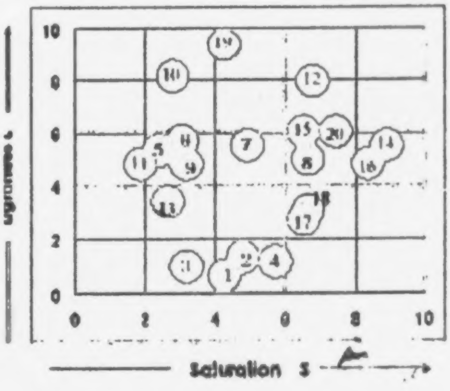


Figure 7 Mapping Result in the Tone (2)

5 Conclusions

We proposed the way of evaluating the beauty and impressive sense of the paintings and design pictures based on the tone in the Muncell color space. We use the tone space, which can concretely express the color impression and a corresponding systematic color names. This method suits the aesthetic impression degree evaluation by the computer because the evaluation processing doesn't depend on the hue.

After getting the image data through the scanner, we convert each RGB pixel the tone space in HLS Muncell color space. We extract the location of the paintings in the tone space by calculating the coefficient of the occupied area. The aesthetic impression is estimated by the location of the used color in the tone space.

The famous paintings from renaissance to modern are tested for extracting the impression feeling. “Mona Lisa” of Leonardo da Vinci and Gogh’s “Sun Flower” is estimated as matured darkly and strongly passionate impression respectively. These results tell us that the distinction by the computer coincide with an established reputation of the paintings.

The impression extraction by this way is useful for the students learning how to use color arrangement in their fine arts subject.

Acknowledgments

This research was supported by Grant-in Aid for Scientific Research on priority areas (12040229) from the Japanese Ministry of Education and Culture.

References

[1] K., Hachimura, " Retrieval of Paintings Using Principal Color Information," Proc. 13th ICPR, pp.130-134, 1996.
[2] A., Tojima and K, Hachimura, "Extraction of compositional feature from paintings and application for retrieval," Trans. IPS Japan, vol.40, no.3, pp.912-920, Mar. 1999.
[3] H., Kimoto, "An image retrieval system using impressional words and the evaluation of the system," Trans. IPS Japan, vol.40, no.3, pp.886-898, Mar. 1999.
[4] H. Nozaki and Y. Isomoto, "Information retrieval for fine arts database system," Trans. IEICE Japan, vol.E80-D, no.2, pp.206-211, Feb. 1997.
[5] E., Masuyama, "How to analyze the impression of paintings from the point of KANSEI engineering," Proc. JSISE Conf. '97, K3A32a4, pp355-358, Sep. 1997.
[6] T. Yamasaki, T. Hattori, “ An Aesthetic Impression Extraction of Paintings for the Fine Arts Subject,” Int. Con. Computers in Education (ICCE99), pp.329-332, 1999.
[7] Nihon Color Research Institute, “PCCS Harmonic Color Charts,” 1999.

AWETS: An Automatic Web-Based English Testing System

Zhao-Ming Gao
Department of Foreign Languages and Literatures
National Taiwan University
Taipei 106, TAIWAN
E-mail: zmgao@ccms.ntu.edu.tw

Test items are traditionally created by experts. While this approach has many advantages, it is laborious and time-consuming. Recent advance in corpus-based computational linguistics has shed new light on the feasibility of a computer-based language testing system capable of automatically generating items. This paper describes AWETS, an automatic web-based English testing system developed by the author's research team and used in his freshman English classes at National Taiwan University. AWETS automates test item generation, test delivery, scoring, and record keeping. It can generate random items for each testee in accordance with the input conditions of the test administrator. With AWETS, testers' jobs are reduced to inputting information such as a list of words and the time limit of each question. Besides being a useful tool for creating achievement tests in English vocabulary, AWETS can also generate proficiency tests based on a selected difficulty level without the need to input a word list. AWETS can be seen as a significant step toward future computer-based language testing system.

Keywords: **automatic generation of items, computer-based language testing, corpus-based computational linguistics, vocabulary testing**

1 Introduction

Test databank in current computer-based language testing systems is mostly created by human experts. This procedure is laborious and time-consuming. Moreover, since test databank is difficult to adapt, teachers using the systems have to spend a lot of time creating the tests for their own classes. To solve this problem, several researchers have suggested the feasibility of designing a tool to automatically generate items. For instance, [4] proposes creating a vocabulary test or exercise from a general corpus using a concordancer, and [5] suggests automatically generating CALL exercise from an electronic dictionary and a parsed corpus. Along the same line of research, we build AWETS, an automatic web-based English testing system that can greatly facilitate the creation of multiple choice vocabulary test. The system, designed with the central concern of adaptability, can generate multiple choice vocabulary test items in accordance with the conditions input by test administers. The system consists of three independent yet interrelated modules: the item generation module, the test delivery module, and the record keeping module.

2 The Item Generation Module

The system is developed based on a large collection of electronic texts and natural language processing tools such as a morphological analyzer and a part-of-speech tagger. The procedures of building the system are as follows.

1. Collection of a Text Database: We retrieve free electronic English texts from the internet primarily from Project Gutenburg and the Sinorama Magazine. Texts in Project Gutenburg are mainly literary works, while those in the Sinorama Magazine contain articles about the culture and events in Taiwan. To ensure that the retrieved texts are not too difficult for our learners, we only include works published after 1960.

The corpus size is about 0.2 million words.

2. Lemmatization: All the retrieved texts are processed by a morphological analyzer developed by University of Pennsylvania which changes regular and irregular inflections into their lemmas, i.e. basic forms (e.g. ran => run, happier => happy).
3. Frequency counts of lemmas: After lemmatization, frequency count of each lemma in the entire corpus is conducted.
4. Sorting of the frequency count of the lemmas in descending order:
5. Identification of the difficulty levels of each lemma: Three levels of difficulty are specified. They correspond to college entrance exams, TOEFL, and GRE. Each level has a range of adjustable values. At present, the range of these three values is stipulated as follows.

College Entrance Exam	Words which fall in the range of the most frequently occurring 3000 – 5000 lemmas
TOEFL	Words which fall in the range of the most frequently occurring 5001 – 7000 lemmas
GRE	Words which fall in the range of the most frequently occurring 7001 – 9000 lemmas

6. Tagging: Each text is processed by Eric Brill's tagger which labels each word its part-of-speech information.
7. Indexing of each word: A database is created which records the documents and position in which a word occurs so that sentences containing a specified word can be retrieved in no time.

Test administrators can choose the level of difficulty, the part-of-speech of words, as well as the number of questions to be tested. Once the choices are made, the system will randomly retrieve sentences which meet the input conditions via the index. A subroutine then converts the retrieved sentences into multiple choice questions. The distracters of the questions are chosen from words of the same difficulty level as the target word. Figure 1 is the user interface for inputting conditions. Figure 2 is the automatically generated test items.

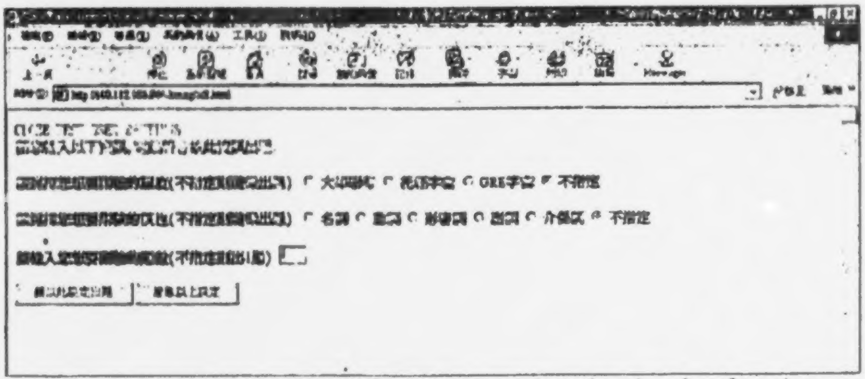
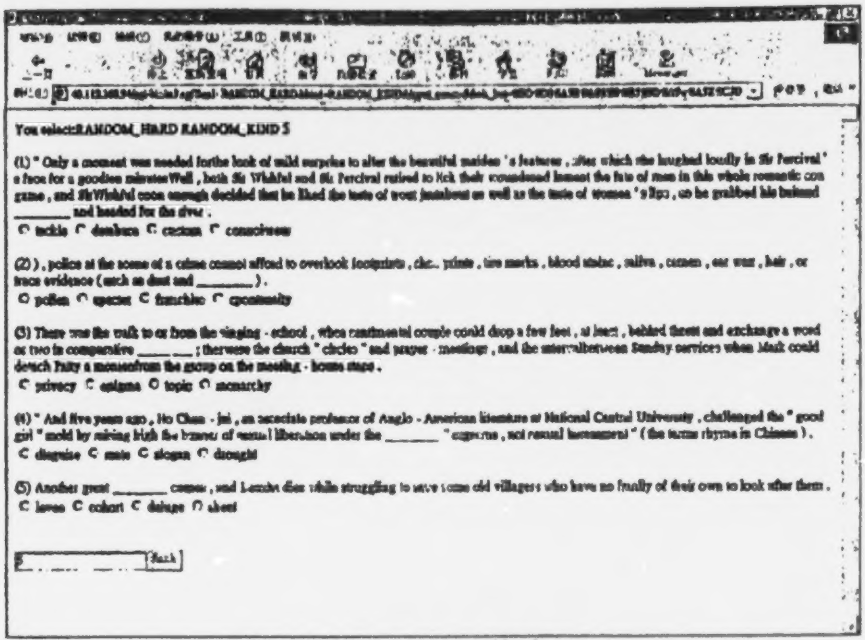


Figure 1. User interface to choose difficulty level, part-of-speech, and number of questions



You select:RANDOM_HARD RANDOM_KIND 5

(1) " Only a moment was needed forthe look of mild surprise to alter the beautiful maiden ' s features , after which she laughed loudly in Sir Percival ' s face for a goodten minutesWell , both Sir Wishful and Sir Percival retired to lick their wounds and lament the fate of men in this whole romantic con game , and SirWishful soon enough decided that he liked the taste of [illegible] [illegible] as well as the taste of women ' s lips , so he grabbed his beloved ________ and headed for the river .
○ tackle ○ [illegible] ○ custom ○ consciousness

(2)) , police at the scene of a crime cannot afford to overlook footprints , [illegible] prints , tire marks , blood stains , saliva , semen , ear wax , hair , or trace evidence (such as dust and ________) .
○ pollen ○ species ○ franchise ○ spontaneity

(3) There was the walk to or from the singing - school , when sentimental couple could drop a few feet , at least , behind these and exchange a word or two in comparative ________ ; therwere the church " circles " and prayer - meetings , and the intervalbetween Sunday services when Mark could detach Patty a momentfrom the group on the meeting - house steps .
○ privacy ○ enigma ○ topic ○ monarchy

(4) " And five years ago , Ho Chuan - jui , an associate professor of Anglo - American literature at National Central University , challenged the " good girl " mold by raising high the banner of sexual liberation under the ________ " orgasms , not sexual harassment " (the terms rhyme in Chinese) .
○ disguise ○ mate ○ slogan ○ drought

(5) Another great ________ comes , and Lamchi dies while struggling to save some old villagers who have no family of their own to look after them .
○ [illegible] ○ cohort ○ deluge ○ sheet

Figure 2. Test items generated by the system

As shown in Figure 2, the system is capable of generating individualized on-line vocabulary tests in the context of cloze tests based on the conditions input by a user. The system can thus be used as an excellent tool for self-paced vocabulary learning. If a learner wants to practice verbs at the TOEFL level, the system can create hundreds of such questions. As soon as he submits his answer, the system can check his answer and immediately present the correct answer to the user. Besides, if a test administer wants to change the difficulty level of the test, he can do it easily by changing the frequency range. To further facilitate the creation of vocabulary tests, the system also allows the test administer to decide which word should be tested. This is particularly useful for creating achievement tests. Once the tester inputs the words and the number of questions, the system can randomly generate multiple choice vocabulary tests in the context of cloze tests. Besides a corpus, AWETS also uses Wordnet, a lexical database developed at Princeton University, to generate items. It extracts the explanation of a lexical item and create multiple choice questions based on the item.

3 The Test Delivery Module

As described above, the item generation module can randomly create a specified number of questions in accordance with the input conditions by a test administer. To make test delivery more efficient, the test databank is created off-line. In other words, all the sentences meeting the input conditions are retrieved before the test starts. These sentences are converted into test items by a subroutine and then stored in the database. A subroutine then randomly retrieves a specified number of items from the databank and present them to the testees when the test starts. To ensure wide and unpredictable sampling, the subroutine is designed in such a way that no two tests are identical and no word will be tested twice in any test. The AWETS database also provides an interface (cf. Figure 3) for the test administer to input specification for the test. The interface allows the test administer to input the name of the test, the number of items, the time limit during which each question should be answered, and the number of times each testee can take the test. The test administer can further choose which classes and which words should be included in the test. After the test information is input by the test administer, testees proceed with the following procedures. They first input their user names and passwords. Before the real test begins, they are given 5 questions for practice. This procedure can help testees become familiar with the format of the questions. An interface and a test item such as Figure 4 is presented to the testees. As mentioned earlier, each question must be answered within a specified time limit. As soon as a question appears on the screen, the system begins to count down the time left. The randomized questions and the time limit make cheating in the examinations much more difficult. Without these two functions, students might try to find answers from the person who sit next to them or from an on-line dictionary. The countdown device might also achieve a beneficial backwash, because testees need to speed up reading the question in order to finish the questions within the time limit.

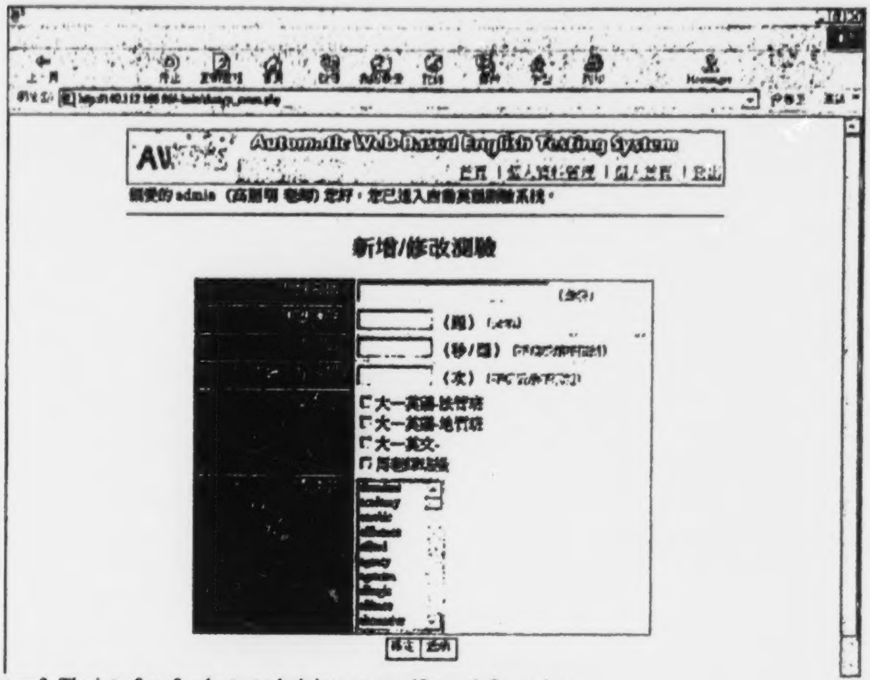

Automatic Web-Based English Testing System
新增/修改測驗
☐ 大一英文-

Figure 3. The interface for the test administer to specify test information

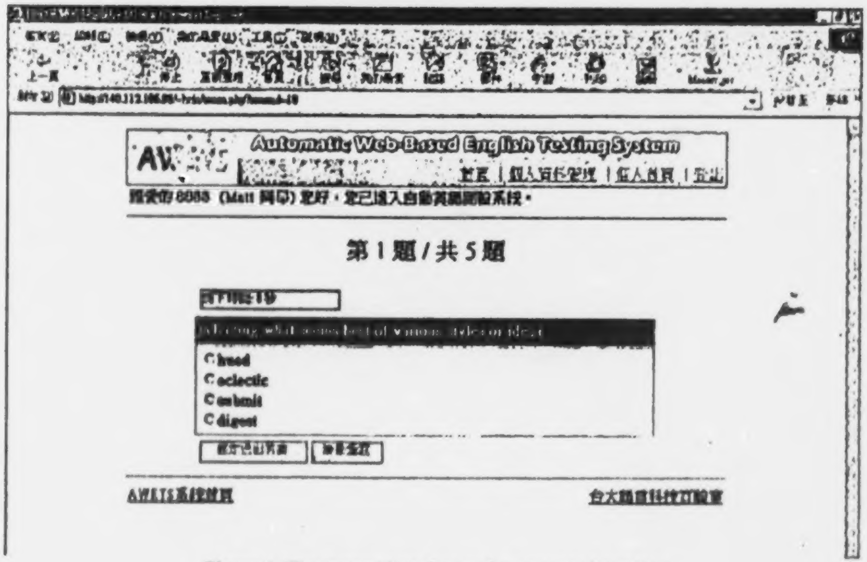
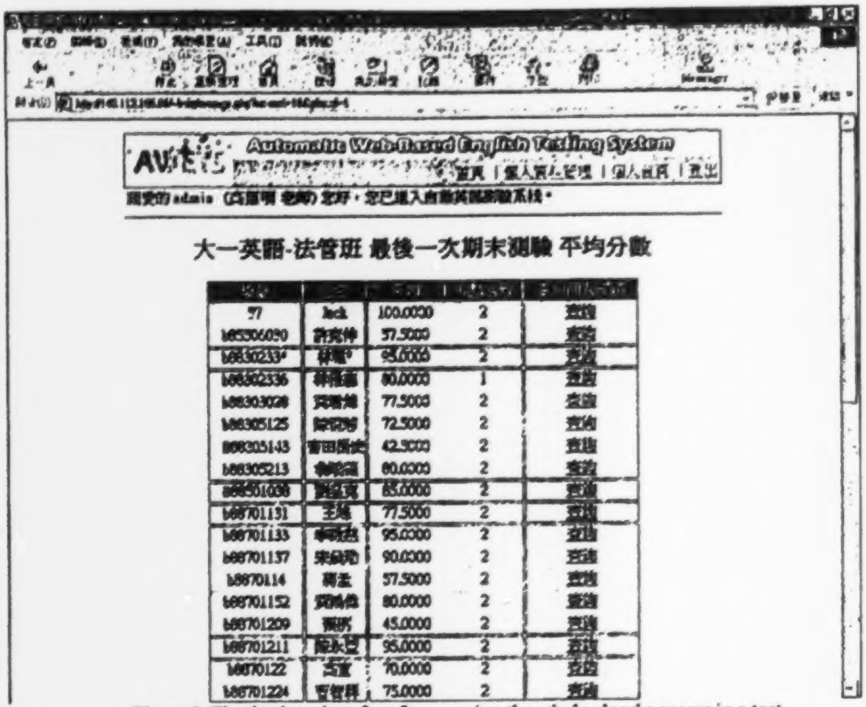

Automatic Web-Based English Testing System
第 1 題 / 共 5 題
○ heed
○ eclectic
○ submit
○ digest

Figure 4. The testees' interface and a generated test item

4 The Record Keeping Module

After each test, the system records the registration number, the name of the student, the test id number, the name of the test, as well as the student' s score in each test. The database component allows teachers to query a student' s record or the whole class's scores in an exam via the interface in figure 5.


Automatic Web-Based English Testing System
AWETS
首頁 | 個人資料管理 | 個人首頁 | 登出

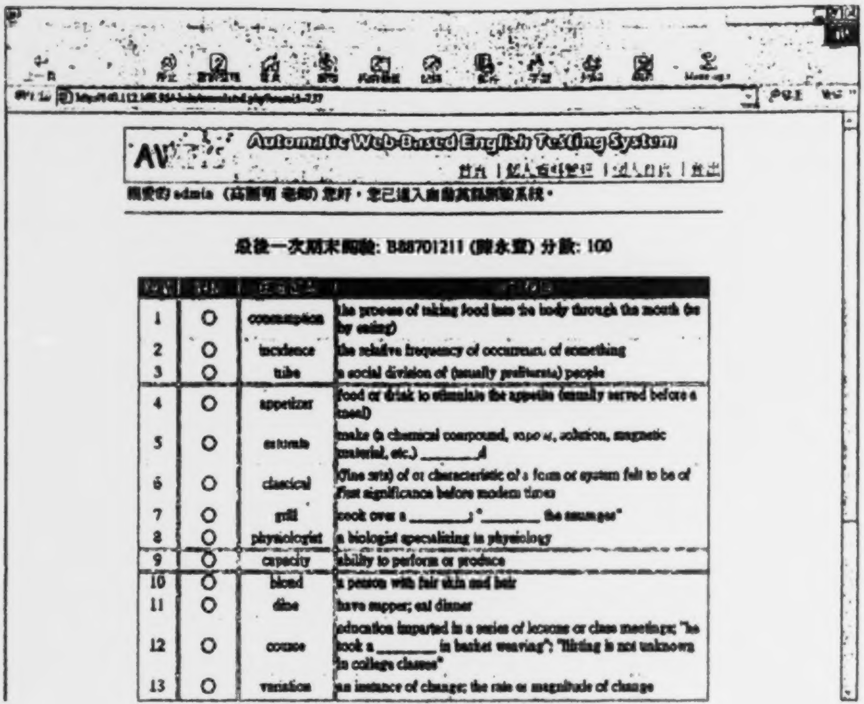
大一英語-法管班 最後一次期末測驗 平均分數

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	Jack	100.0000	2	查詢
b85306090	[illegible]	57.5000	2	查詢
b8830233[illegible]	[illegible]	95.0000	2	查詢
b88302336	[illegible]	80.0000	1	查詢
b88303028	[illegible]	77.5000	2	查詢
b88305125	[illegible]	72.5000	2	查詢
b88305143	[illegible]	42.5000	2	查詢
b88305213	[illegible]	60.0000	2	查詢
b88501038	[illegible]	85.0000	2	查詢
b88701131	[illegible]	77.5000	2	查詢
b88701133	[illegible]	95.0000	2	查詢
b88701137	[illegible]	90.0000	2	查詢
b8870114	[illegible]	57.5000	2	查詢
b88701152	[illegible]	80.0000	2	查詢
b88701209	[illegible]	45.0000	2	查詢
b88701211	[illegible]	95.0000	2	查詢
b8870122	[illegible]	70.0000	2	查詢
b88701224	[illegible]	75.0000	2	查詢

Figure 5. The database interface for querying the whole class' s scores in a test

The database component greatly facilitates the calculation of validity and reliability. When testees are given more than one set of test items in a given test, the correlation of the scores can be easily computed. The system also records all the questions and testees' responses. These data can be used to analyze testees' test-taking strategies. With this function, item analysis is possible although no test candidates have identical tests.

BEST COPY AVAILABLE



親愛的 admin ([illegible] 老師) 您好，您已進入自動英語測驗系統。

最後一次期末測驗: B88701211 ([illegible]) 分數: 100

[illegible]	[illegible]	[illegible]	[illegible]
1	○	consumption	the process of taking food into the body through the mouth (as by eating)
2	○	incidence	the relative frequency of occurrence of something
3	○	tribe	a social division of (usually preliterate) people
4	○	appetizer	food or drink to stimulate the appetite (usually served before a meal)
5	○	saturate	make (a chemical compound, vapor, solution, magnetic material, etc.) ________d
6	○	classical	(fine arts) of or characteristic of a form or system felt to be of first significance before modern times
7	○	grill	cook over a ________; "________ the sausages"
8	○	physiologist	a biologist specializing in physiology
9	○	capacity	ability to perform or produce
10	○	blond	a person with fair skin and hair
11	○	dine	have supper; eat dinner
12	○	course	education imparted in a series of lessons or class meetings; "he took a ________ in basket weaving"; "flirting is not unknown in college classes"
13	○	variation	an instance of change; the rate or magnitude of change

Figure 6. A student's responses to the test items

5 Some Problems of AWETS

Although AWETS performs relatively well, there are some limitations which prevent it from being a completely reliable testing instrument. First, the basic assumption that difficulty of words can be determined by frequency is challenged by some scholars, since there are some words common in everyday life but much less common in texts. Moreover, a word might have several meanings some of which are much more difficult than the others. The approach proposed in this paper cannot distinguish the difficulty of the different meanings of a word. Another question is whether there might be more than correct answer in generated test items. When AWETS automatically creates multiple choice questions, it randomly chooses distracters from the dictionary. Although the distracters rarely fit the context, it might happen that some of them are acceptable. Note that choosing distracters with different parts-of-speech from the target word does not solve the problem, because a word might be used in different parts-of-speech. It should also be admitted that although AWETS can create individualized tests, it lacks a rigid method to ensure equal difficulty for all testees. Another technical problem involved is that the part-of-speech tagging program and the program which identifies sentence boundary is not one hundred percent correct. This might result in undesirable test items. Even when sentence boundary is correctly identified, some sentences might not be appropriate in testing a learner when taken out of context. This is particularly true of short sentences. Long sentences, however, are not always unproblematic. In a vocabulary test, all the words in the sentence are meant to give the contextual clues except the target word. In other words, the target word should ideally be the most difficult word in the sentence. Consequently, if there is a word in the same sentence more difficult than the target word, the test item might not be appropriate. Questions like these all require more rigid methods than those adopted in current implementation of AWETS.

6 Conclusion and Future Research

In this paper, we introduce AWETS, a web-based system that can automatically create vocabulary tests and adapt items according to the conditions input by test administers. AWETS greatly facilitates the creation of vocabulary tests and has fully automated procedures for item generation, test delivery, scoring, and record keeping. At present, the validity and reliability of the automatically generated test items are being investigated. Future research will focus on solving the problems noted in section 5 by using sense-tagged texts and more rigid methods to identify difficulty of words.

Acknowledgements: The author wishes to thank Miss Lin Gui-Guang, Miss Liang Jing-Xiou, Mr. Zhao Zheng-Ming, and Mr. Lin Zheng-Ru for helping implement AWETS. AWETS is supported in part by a grant from the Computing and Information Network Center at National Taiwan University for the promotion of asynchronous learning.

References

[1] Bulter, Jonathan. Cloze procedures and concordances: The advantages of discourse level authenticity in testing expectancy grammar. System 19, 1/2, pp. 29-38, (1991).
[2] Hughes, Arthur. Testing for Language Teachers. Cambridge University Press, (1989).
[3] Stevens, Vance. Classroom concordancing: Vocabulary materials derived from relevant authentic text. English for Specific Purposes Journal 10: 35-46, (1991).
[4] Wilson, Eve. The Automatic Generation of CALL Exercises form General Corpora. In Wichmann et al. (eds.) Teaching and Lanuage Corpora. Longman, pp. 116 – 130, (1997).

Building the Multi-tier Architecture of Component-Oriented Multimedia CAI Systems on Internet

Min-Huei Lin , Ching-Fan Chen, Chen-Nan Chiang
Department of Information Management
Aletheia University
Tamsui, Taiwan, R.O.C
Email: lmh@email.au.edu.tw, cfchen@email.au.edu.tw

The popularity of WWW (World Wide Web) produces lots of new instructions or substitutive cases to build a new future, therefore educational units need to develop various computer-assisted instructions. To ensure good learning effect, the instructive strategy adopted by most CAI systems is to provide tremendous amount of multimedia data in order to attract the learner and a complete process of instruction is like the scenario of a presentation. The purpose of this thesis is to discuss how the multi-tier developing architecture can let the multimedia learning resources be used and shared in WWW from a view of organization's requirements, such that teachers, measuring researchers, and learning researchers can perform different tasks according to their own specialties independently. We also propose and implement a multimedia presentation system to let various authors with various identities author and present their presentation, i.e. CAI systems, conveniently and correctly. We compare the general hierarchy of a multimedia presentation system with the multi-tier architecture proposed by us, and we can know how the tasks are divided and assigned to corresponding professionals to accomplish the whole teaching materials through working cooperatively. It is possible to have a suggestion to develop CAI software for educational department.

Keywords: **Multimedia Presentation System, CAI System, Multi-tier**

1 Introduction

Although there exists many arguments, object oriented is still spread out in 1990's and it seems to be a possible survival direction in software crisis. Besides this, we can use component oriented to build a set of CAI systems via existing papers that can be divided into several areas, e.g. research of interface, learning methods of computer assisted instructions, application of virtual reality, networking exam, virtual classrooms (including distance instruction), individual researcher objects, and etc. For example, the processes of mental model research emphasize the use of information of objects, so researchers just make the analysis components of mental model, the key point of this study is the component of mental model, not the scenario of teaching and the interface of designation. Another example, fuzzy theory should be used in the research of learning analysis, the key point is to provide learning analysis for content of exam, and it can make the analysis component purely. From the two examples, we can find the generation in proper components analysis, so all we have to do is making the component of its own domain. Each researcher only concerns its own theme without being concerned with the entire system, then can reuse the resources and get the complete experimental environment. This thesis constructs the developing architecture of CAI through component oriented and logical dividing of multi-tier structure, and emphasizes that the discussion of developing architecture is the beginning of the series of research.

2 Multimedia presentation system

BEST COPY AVAILABLE

2.1 General Hierarchy of Multimedia Presentation System

On Internet, the way to play multimedia objects is hypermedia shown in the Fig.1. To display such a scene on homepages, we can divide the designation into two layers, frame layer and resource object layer. The resource object layer stores all the multimedia objects participated in playing, the frame layer records the objects that compose each frame, the schedule of playback, the arrangement of objects on screen, and the events that may change the playing flow of inter-frames.

A multimedia resource may be a picture, a text description, a video, or other materials that can be used in a multimedia computer. A topic is a resource carrier that presents the resource to the addressee. A frame is a composite object that represents related issues that a presenter wants to illustrate. A frame may contain push buttons, one or more topics to be presented, and a number of knowledge. A message with optional parameters can be passed between two frames (or back to the same frame) to trigger a multimedia presentation action.

In the two layers, we make some definitions by referring the various links defined in [7].
An inheritance* (successor or precedence) *link: is a property inheritance between two frames and is used in the process of knowledge collection of an activated frame before the logical inference of the frame proceeds.
A usage link: is a link that represents a message passed between two frames.
An aggregation link: indicates that a frame is using a resource.
A resource association link between two resources: indicates that the two resources are correlated.
A frame association link between two frames: indicates that the two frames are correlated.

2.2 Models of Presentation systems

In 1983, James F. Allen advocated in ACM• There exist thirteen temporal relationships between two intervals, namely, before, meets, overlaps, during, starts, finishes and the other six inverse relations as well as equal. The thirteen corresponding temporal operators constructed from the Allen's interval-based temporal logic are depicted in Fig. 2.

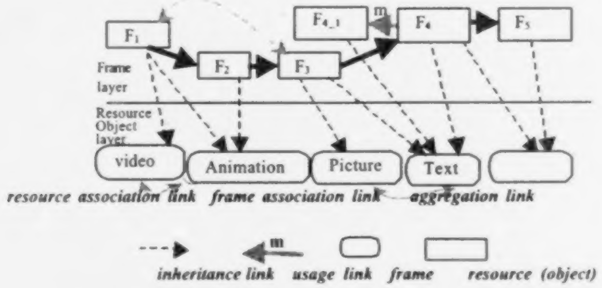
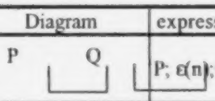
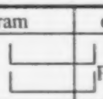
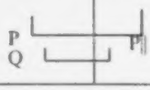


Fig.1 the way to play multimedia objects on Internet is hypermedia

Relation	Diagram	expressions	relation	Diagram	expressions
P before Q	 P Q	P; ε(n);Q	P before Q		Q P $P \| Q$
P meets Q	P Q	P;Q	P meets Q		P Q $P \| Q$
P during Q	 P Q	$P \| Q$	P during Q		P $P \| Q$ Q

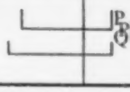
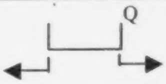
Relation	Diagram	expressions	relation	Diagram	expressions
P finishes Q		$P \| Q$	Start-time		End-time

Fig. 2 Temporal Relationships (Allen 1983) and their corresponding temporal operators

2.3 Define the Playback of Multimedia Presentation

We define some notations used in our presentation system. The F_i denotes the frame in the frame layer. The O_i denotes the resource in resource layer. The $F_i.O_i$ denotes that the resource O_i is one component of the frame Fi. The m_i denotes a triggered message when users push a button, a hypertext or a hypermedia. The m_iF denotes that the frame F will be displayed after the message mi is triggered, and the m_eF denotes that the frame can be directly displayed not depend whether the message is triggered or not.

For example, a presentation displayed one frame by one frame can be described by the following expression $S = m_eF_1\ (m_iF_{21}+m_eF_{22})\ m_eF_3\ m_eF_4\ (m_iF_{51}+m_eF_{52})$. According to Fig.1, we know that the $F_i.O_i$ is an aggregation link, m_eF_1 is an inheritance link, and m_iF_1 is a usage link.

2.3.1 Define the Properties of scenario

A complete process of instruction is just like the scenario of a presentation, and can also be described by the expression $S = m_eF_1\ (m_iF_{21}+m_eF_{22})\ m_eF_3\ m_eF_4\ (m_iF_{51}+m_eF_{52})$.

2.3.2 Define the Properties of Objects

We denote a media object as O = (N, T, D, UM, OAL, PT), and describe the attributes of an object below:
O_i.N *(Name)*: is the identifier of the object.
O_i.T *(type)*: What multimedia device is used to carry out this resource (e.g. sound, video, text or picture).
O_i.D *(Duration)*: records the display time of the object.
O_i.UM *(Usage model)*: the situation about the usage of objects, such as the object is a background or a referent.
O_i.OAL *(object association link)*: describes the relationships between objects, and is specified like
O_i.FAL={O_1(*association Keyword description*), O_2 (*association Keyword description*) ,..}, we use association keywords to describe the related relationships between O_i and O_1, the same as O_i and O_2.
O_i.PT *(Player Type)*: describes the way to play the object.

2.3.3 Define the Properties of Frames

A frame F_i is denoted as F_i =(N, O, FAL, L, P, UM), and the meanings of its attributes are listed below:
F_i.N*(Name)*: assign a unique name to a frame F_i.
F_i.O*(resource objects)*: the set of all the resource objects participated in the frame F_i, $O = \{O_i \mid O_i \in O\}$.O is the set of all objects stored in database.
F_i.FAL*(frame association link)*: $F_i.FAL = \{(C_i, F_k) \mid C_i \in \{◈, \odot\}, F_k \in F\}$.The relationships between F_i and F_j are divided into inclusive and exclusive relationships; we denote them by $\odot$ and ◈ respectively. The $F_i \odot F_j$ represents the two frames are inclusive, that is, whenever the F_i is displayed, the F_j must be displayed also. The F_i◈F_j represents the two frames are exclusive, that is, whenever the F_i has been displayed, the F_j can't be displayed. F is the set of all frames.
F_i.L *(Layout)*: the spatial arrangement of the objects of F_i for the presentation. For example, the (X_{j1}, Y_{j1}) and (X_{j2}, Y_{j2}) are the position on the screen arranged for O_j, $F_i.L = \{O_1\ (X_{11},Y_{11})(X_{12},Y_{12}),\ O_2\ (X_{21},Y_{21})(X_{22},Y_{22}), \ldots\}$.
F_i.P *(Presentation)*: the duration of playback of all objects in the F_i. We use the 13 temporal relations proposed by Allen and use ε(n) to represent units of time. OP is the set of all operators used to describe the temporal relations between objects. P is a set composed of O_i OP O_j, $P = \{(O_i, op, O_j) \mid O_i, O_j \in O, op \in OP\}$, $OP = \{\,;, \|, \|, \|, \|, \|, \varepsilon(n)\}$,$F_i.P = \{\cup P_i \mid P_i \in P\}$. For example, $F_i.P = \{(O_1 \| O_2),(O_1 \| O_3),(O_3 ; O_4),..\}$.
F_i.UM*(Usage model)*: describes usage of frames, e.g. the frame is designed for teaching or for taking exams. For example, expression F_i.UM = exam means that the frame is an exam frame.

3Three-layer CAI architecture

3.1 Partition the CAI system into Components

The flow of instruction is from teaching course, taking examinations, speculating the advanced contents of instruction according to the result of examination, to achieve the goal of instruction. Generally, the teachers, educators or scholars take part in editing the CAI systems and the computer engineers are responsive for implementing the CAI systems, so they often spent lots of time on mutual communication. We analyze the CAI systems and partition the CAI systems into various components that are designed by various persons respectively, and these persons work together to achieve the whole function of the CAI systems. To partition the components clearly, we use the UML to describe the flow of CAI systems shown in the Fig.3, and we can know the following things:

- Step1 to step4 is for identifying the users.
- Step5 to step8 is for displaying the teaching of courses or questions of exams.
- Step9 to step11 is for analyzing after the exams are finished.
- Step12 to step14 is for designing the advanced courses after the fitting analysis is finished.
- Step15 is for exiting the CAI system.

In Fig.3, we can classify the partitioned components of CAI systems into four kinds listed below.

- The verification component for logging the usage of systems and maintaining the security of system. —is managed by system administrators or computer engineers.
- The course and exam component for instructing students in learning and taking exams. —is managed by teachers, educators or scholars.
- The fitting analysis component for the learning process of students. —is made by educators and scholars.
- The database component for storing the media objects and instruction materials. —is implemented by art designers or computer workers, and is managed by computer engineers.

3.2 Three-layer CAI architecture

From the CAI system described with UML shown in Fig.3, we can know that the course and exam component is the most important one and the other components are discussed in other area. In our system, we propose the Multi-layer CAI architecture to construct the CAI systems, and use the management of components to distribute the resources over the servers on Internet to achieve the goal of resource sharing.

We present a 3-layer CAI architecture model that expresses different points of view and is fully flexible and component oriented [2,3]. Based on the efficiency of systems, the model is partitioned into 3 layers--resource layer, presentation layer and evaluation layer. It raises the productivity of system development and improvement process, also promotes the individual skills and development of distributed computing environment.

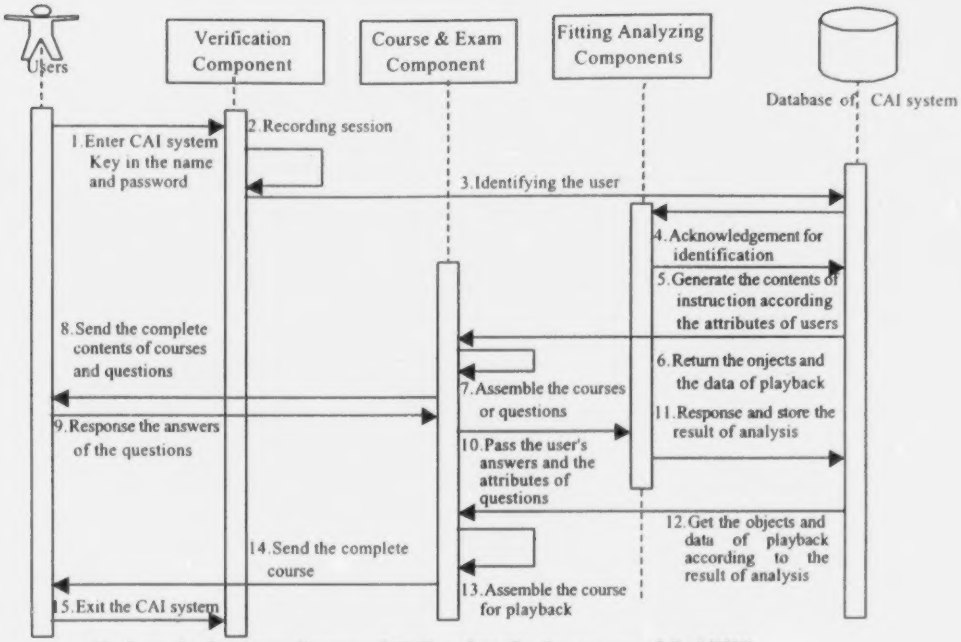

Users
Verification Component
Course & Exam Component
Fitting Analyzing Components
Database of CAI system
1.Enter CAI system Key in the name and password
2.Recording session
3.Identifying the user
4.Acknowledgement for identification
5.Generate the contents of instruction according the attributes of users
6.Return the onjects and the data of playback
7.Assemble the courses or questions
8.Send the complete contents of courses and questions
9.Response the answers of the questions
10.Pass the user's answers and the attributes of questions
11.Response and store the result of analysis
12.Get the objects and data of playback according to the result of analysis
13.Assemble the course for playback
14.Send the complete course
15.Exit the CAI system

Fig.3 use the Sequence diagram of UML to describe the process of CAI [8][9]

3.3 Relationship between Three-layer CAI architecture and hypermedia

From the Table 1 and the frame and resource objects defined in our multimedia presentation system, we can analyze that to what layer the settings of various objects belong listed in Table 2[2][4]. In the components of scenario, we define the miFi that describes which frame should be displayed after the message is triggered, i.e. we can use the expressions to define the schedule of playback of the frames about designing exams and teaching. The components of plot or story just describe the flow of teaching courses defined by users.

From Table 3, we can design and implement the system on Internet more easily to let teachers or other education experts design their teaching materials or questions of exams conveniently and systematically.

4 Conclusion

Different researchers can benefit from this architecture by studying their own knowledge domain independently. Shortening the time spent on completely developing the whole system is to promote the successful rate of resolving the kernel problems. Researchers can' t benefit from studying their own domain only; it's necessary for them to know our open architecture that can easily expand one system into various domains.

Users can acquire an easy-used and reusable system from defining components of multimedia and instructive units of CAI. Our architecture lets teachers have the suitable flexibility and lets various experts and scholars participate in the installation of CAI system. The educational authorities can take our architecture as a referenced architecture for developing the multimedia education. Our system is shown in Fig. 4. The prototype of our system has been completely implemented and published in some various conferences or journals. [1] [5] [9] [10]

Table 1. Three-layer CAI architecture [2][4]

Layer	Researcher	Participants
Resource	Researcher of Interface	Designer of animation , graphic, sound
Presentation	Researcher of learning theory	Teacher, Instructor
Evaluation	Researcher of evaluation	Manager, researcher of educational policy

Table 2. Explanation of part of components [2][4]

First layer (Evaluation layer)	
Components of fitting analysis	This component is made according to some theorem. After analyzing the data acquired from the process that the students take exams and learn, there are some various frames generated.
Components of evaluation and analysis	This component is made according to learning evaluation and learning retrieval of theorist or researchers.
Second layer (Presentation layer)	
Components of scenario	This component is made according to the researchers of learning theory or teaching materials.
Components of structure	This component is made according to learning environment.
Third layer (Resource layer)	
Components of exam	This part must include the parameter or properties which is used broadly
Components of background	Background is concerned to the interest and attention of learner.
Components of referents	To help users of different levels from different method and presentation
Components of multimedia	The components make the CAI lively which may be somebody of cartoon

Table 3. Explanations of part of components

Explanation of part of components		Set the values of necessary item needed
First layer (Evaluation layer)	Components of fitting analysis	
	Components of evaluation and analysis	• F_i.O • F_i.Layout and F_i.UM= exam • F.Presentation and F_i.UM= exam
Second layer (Presentation layer)	Components of scenario	• S
	Components of structure	• F_i.Layout and F_i.UM=learn • F.Presentation and F_i.UM=learn
Third layer (Resource layer)	Components of exam	• O_i.UM = exam
	Components of background	• O_i.UM =Background.
	Components of referents	• O_i.UM = Referents

References

[1] Bal Wang , Ching-Fan Chen, Min-Huei Lin. " A Multimedia Presentation System on Web -- Dynamic Homepage Approach"., The Institute of Electronics, Information and Communication Engineers(IEICE) Transactions on Information and System, Vol.E82-D,NO.4,April 1999. pp. 729-736

[2] Min-Huei Lin, Ching-Fan Chen, Ian-Ru Li, " Building Component Oriented Multi-tier CAI Architecture in the Internet ", ICCE' 98 (The Sixth International Conference on Computers in Education) , Beijing,china,1998,pp.180~pp.186.

[3] Bal Wang , Ching-Fan Chen, Min-Huei Lin , Wei-Yu Li , Ya-Ting Chuang. "A Three-Tier Multimedia Presentation System in Internet", ISMIP 98(International Symposium on Multimedia Information Processing),Taiwan, pp. 162-166.

[4] Bal Wang , Ching-Fan Chen, Min-Huei Lin , Ian-Ru Li. "Building multimedia component oriented Multi-tier CAI architecture in the Internet".ISMIP 98(International Symposium on Multimedia Information Processing),Taiwan, pp. 158-161.

[5] Min-Huei Lin, Bal Wang, Ching-Fan Chen, Chien-Ming Pen , Zheng-Kui Huang , Ian-Ru Li. "An Authoring Tool for Teaching Materials on Web- Dynamic Homepage Approach using SMIL". ICCE' 99(International Conference on Computers in Education).

[6] Min-Huei Lin, Chien-Jen Huang, Shang-Zong You, Bal Wang, Ching-Fan Chen ."Using Adjustable Multimedia Homepage Design—A Scheme to Promote the Effect of Web CAI" . ICCE' 99(International Conference on Computers in Education).

[7] Chung, C.-M.; Shih, T.K.; Kuo, C.-H.; Lin, W.-C. . "Supporting the reuse of multimedia presentations" , Information Sciences, Vol: 101, pp. 131-151.

[8] Min-Huei Lin, Zheng-Kui Huang, Bal Wang, , Ching-Fan Chen• ¥Using Object Oriented Method in Network CAI Model" • The 8th International Conference on Computer-Assisted Instruction.

[9] Min-Huei Lin, Zheng-Kui Huang, Bal Wang , Ching-Fan Chen.• ¥Management of the Object–Oriented Resources Application System – an Instance of Distance Education" • Distance Education. Vol. 12 , June 1999. pp.53-61.

[10] Bal Wang, , Ching-Fan Chen , Min-Huei Lin , Chien-Ming Pan , Jen-Shan Huang , Hsing-Ten Chein• ¥An Authoring Tool on Web" • •The 8th International Conference on Computer-Assisted Instruction.

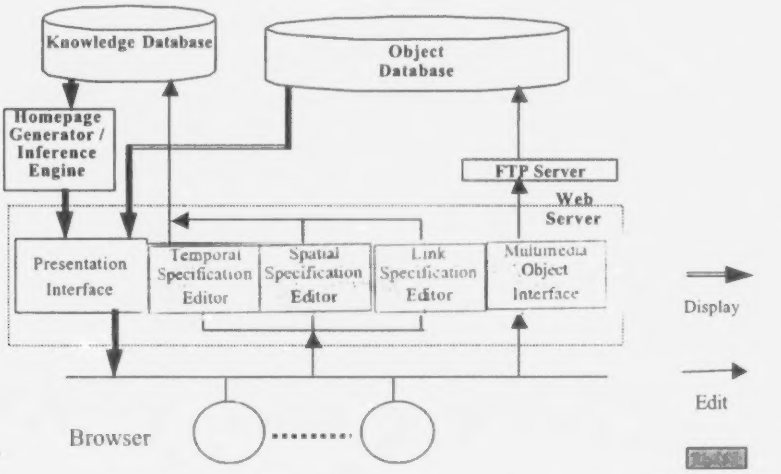

Knowledge Database
Object Database
Homepage Generator / Inference Engine
FTP Server
Web Server
Presentation Interface
Temporal Specification Editor
Spatial Specification Editor
Link Specification Editor
Multimedia Object Interface
Browser
Display
Edit
User Interface

Fig.4. System architecture

Building the Multi-tier Architecture of Component-Oriented Multimedia CAI Systems on Internet

Min-Huei Lin , Ching-Fan Chen, Chen-Nan Chiang
Department of Information Management
Aletheia University
Tamsui, Taiwan, R.O.C
Email: lmh@email.au.edu.tw, cfchen@email.au.edu.tw

The popularity of WWW (World Wide Web) produces lots of new instructions or substitutive cases to build a new future, therefore educational units need to develop various computer-assisted instructions. To ensure good learning effect, the instructive strategy adopted by most CAI systems is to provide tremendous amount of multimedia data in order to attract the learner and a complete process of instruction is like the scenario of a presentation. The purpose of this thesis is to discuss how the multi-tier developing architecture can let the multimedia learning resources be used and shared in WWW from a view of organization's requirements, such that teachers, measuring researchers, and learning researchers can perform different tasks according to their own specialties independently. We also propose and implement a multimedia presentation system to let various authors with various identities author and present their presentation, i.e. CAI systems, conveniently and correctly. We compare the general hierarchy of a multimedia presentation system with the multi-tier architecture proposed by us, and we can know how the tasks are divided and assigned to corresponding professionals to accomplish the whole teaching materials through working cooperatively. It is possible to have a suggestion to develop CAI software for educational department.

Keywords: **Multimedia Presentation System, CAI System, Multi-tier**

1 Introduction

Although there exists many arguments, object-oriented is still spread out in 1990's and it seems to be a possible survival direction in software crisis. Besides this, we can use component oriented to build a set of CAI systems via existing papers that can be divided into several areas, e.g. research of interface, learning methods of computer assisted instructions, application of virtual reality, networking exam, virtual classrooms (including distance instruction), individual researcher objects, and etc. For example, the processes of mental model research emphasize the use of information of objects, so researchers just make the analysis components of mental model, the key point of this study is the component of mental model, not the scenario of teaching and the interface of designation. Another example, fuzzy theory should be used in the research of learning analysis, the key point is to provide learning analysis for content of exam, and it can make the analysis component purely. From the two examples, we can find the generation in proper components analysis, so all we have to do is making the component of its own domain. Each researcher only concerns its own theme without being concerned with the entire system, then can reuse the resources and get the complete experimental environment. This thesis constructs the developing architecture of CAI through component oriented and logical dividing of multi-tier structure, and emphasizes that the discussion of developing architecture is the beginning of the series of research.

2 Multimedia presentation system

2.1 General Hierarchy of Multimedia Presentation System

On Internet, the way to play multimedia objects is hypermedia shown in the Fig.1. To display such a scene on homepages, we can divide the designation into two layers, frame layer and resource object layer. The resource object layer stores all the multimedia objects participated in playing, the frame layer records the objects that compose each frame, the schedule of playback, the arrangement of objects on screen, and the events that may change the playing flow of inter-frames.

A multimedia resource may be a picture, a text description, a video, or other materials that can be used in a multimedia computer. A topic is a resource carrier that presents the resource to the addressee. A frame is a composite object that represents related issues that a presenter wants to illustrate. A frame may contain push buttons, one or more topics to be presented, and a number of knowledge. A message with optional parameters can be passed between two frames (or back to the same frame) to trigger a multimedia presentation action.

In the two layers, we make some definitions by referring the various links defined in [7].
An inheritance* (successor or precedence) *link: is a property inheritance between two frames and is used in the process of knowledge collection of an activated frame before the logical inference of the frame proceeds.
A usage link: is a link that represents a message passed between two frames.
An aggregation link: indicates that a frame is using a resource.
A resource association link between two resources: indicates that the two resources are correlated.
A frame association link between two frames: indicates that the two frames are correlated.

2.2 Models of Presentation systems

In 1983, James F. Allen advocated in ACM• There exist thirteen temporal relationships between two intervals, namely, before, meets, overlaps, during, starts, finishes and the other six inverse relations as well as equal. The thirteen corresponding temporal operators constructed from the Allen's interval-based temporal logic are depicted in Fig. 2.

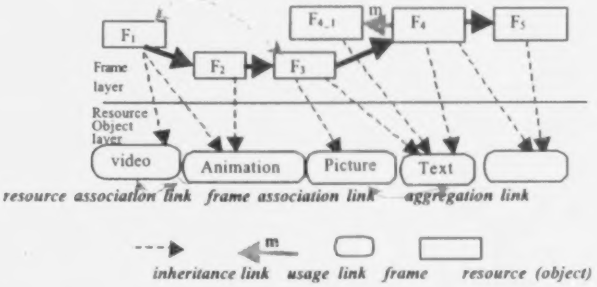


Fig.1 the way to play multimedia objects on Internet is hypermedia

Relation	Diagram	expressions	relation	Diagram	expressions
P before Q	P Q	P; ε(n);Q	P before Q	Q P	P|| Q
P meets Q	P Q	P;Q	P meets Q	P Q	P|| Q
P during Q	P Q	P|| Q	P during Q	P Q	P|| Q

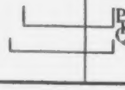
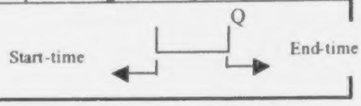
Relation	Diagram	expressions	relation	Diagram	expressions
P finishes Q		$P \| Q$			

Fig. 2 Temporal Relationships (Allen 1983) and their corresponding temporal operators

2.3 Define the Playback of Multimedia Presentation

We define some notations used in our presentation system. The F_i denotes the frame in the frame layer. The O_i denotes the resource in resource layer. The $F_i.O_i$ denotes that the resource O_i is one component of the frame Fi. The m_i denotes a triggered message when users push a button, a hypertext or a hypermedia. The m_iF denotes that the frame F will be displayed after the message mi is triggered, and the $m_\varepsilon F$ denotes that the frame can be directly displayed not depend whether the message is triggered or not.

For example, a presentation displayed one frame by one frame can be described by the following expression $S = m_\varepsilon F_1\ (m_1 F_{21}+m_\varepsilon F_{22})\ m_\varepsilon F_3\ m_\varepsilon F_4\ (m_1 F_{51}+m_\varepsilon F_{52})$. According to Fig. 1, we know that the $F_i.O_i$ is an aggregation link, $m_\varepsilon F_1$ is an inheritance link, and $m_1 F_1$ is a usage link.

2.3.1 Define the Properties of scenario

A complete process of instruction is just like the scenario of a presentation, and can also be described by the expression $S = m_\varepsilon F_1\ (m_1 F_{21}+m_\varepsilon F_{22})\ m_\varepsilon F_3\ m_\varepsilon F_4\ (m_1 F_{51}+m_\varepsilon F_{52})$.

2.3.2 Define the Properties of Objects

We denote a media object as O = (N, T, D, UM, OAL, PT), and describe the attributes of an object below:
O_i.N *(Name)*: is the identifier of the object.
O_i.T *(type)*: What multimedia device is used to carry out this resource (e.g. sound, video, text or picture).
O_i.D *(Duration)*: records the display time of the object.
O_i.UM *(Usage model)*: the situation about the usage of objects, such as the object is a background or a referent.
O_i.OAL *(object association link)*: describes the relationships between objects, and is specified like **O_i.FAL**=$\{O_1$(*association Keyword description*), O_2 (*association Keyword description*) ,..}, we use association keywords to describe the related relationships between O_i and O_1, the same as O_i and O_2.
O_i.PT *(Player Type)*: describes the way to play the object.

2.3.3 Define the Properties of Frames

A frame F_i is denoted as F_i =(N, O, FAL, L, P, UM), and the meanings of its attributes are listed below:
F_i.N*(Name)*: assign a unique name to a frame F_i.
F_i.O*(resource objects)*: the set of all the resource objects participated in the frame F_i, $O = \{O_i \mid O_i \in O\}$.O is the set of all objects stored in database.
F_i.FAL*(frame association link)*: $F_i.FAL = \{(C_i, F_k) \mid C_i \in \{\Diamond, \odot\}, F_k \in F\}$.The relationships between F_i and F_j are divided into inclusive and exclusive relationships; we denote them by $\odot$ and $\Diamond$ respectively. The $F_i \odot F_j$ represents the two frames are inclusive, that is, whenever the F_i is displayed, the F_j must be displayed also. The $F_i \Diamond F_j$ represents the two frames are exclusive, that is, whenever the F_i has been displayed, the F_j can't be displayed. F is the set of all frames.
F_i.L *(Layout)*: the spatial arrangement of the objects of F_i for the presentation. For example, the (X_{j1}, Y_{j1}) and (X_{j2}, Y_{j2}) are the position on the screen arranged for O_j, $F_i.L = \{O_1\ (X_{11},Y_{11})(X_{12},Y_{12}),\ O_2\ (X_{21},Y_{21})(X_{22},Y_{22}), \ldots\}$.
F_i.P *(Presentation)*: the duration of playback of all objects in the F_i. We use the 13 temporal relations proposed by Allen and use $\varepsilon(n)$ to represent units of time. OP is the set of all operators used to describe the temporal relations between objects. P is a set composed of O_i OP O_j, $P=\{(O_i, op, O_j) \mid O_i, O_j \in O, op \in OP\}$, $OP = \{ ;, \|, \|, \|, \|, \|, \varepsilon(n)\}$, $F_i.P=\{\cup P_i \mid P_i \in P\}$. For example, $F_i.P=\{(O_1 \| O_2),(O_1 \| O_3),(O_3 ; O_4),..\}$.
F_i.UM*(Usage model)*: describes usage of frames, e.g. the frame is designed for teaching or for taking exams. For example, expression F_i.UM = exam means that the frame is an exam frame.

3Three-layer CAI architecture

3.1 Partition the CAI system into Components

The flow of instruction is from teaching course, taking examinations, speculating the advanced contents of instruction according to the result of examination, to achieve the goal of instruction. Generally, the teachers, educators or scholars take part in editing the CAI systems and the computer engineers are responsive for implementing the CAI systems, so they often spent lots of time on mutual communication. We analyze the CAI systems and partition the CAI systems into various components that are designed by various persons respectively, and these persons work together to achieve the whole function of the CAI systems. To partition the components clearly, we use the UML to describe the flow of CAI systems shown in the Fig.3, and we can know the following things:

- Step1 to step4 is for identifying the users.
- Step5 to step8 is for displaying the teaching of courses or questions of exams.
- Step9 to step11 is for analyzing after the exams are finished.
- Step12 to step14 is for designing the advanced courses after the fitting analysis is finished.
- Step15 is for exiting the CAI system.

In Fig.3, we can classify the partitioned components of CAI systems into four kinds listed below.

- The verification component for logging the usage of systems and maintaining the security of system. —is managed by system administrators or computer engineers.
- The course and exam component for instructing students in learning and taking exams. —is managed by teachers, educators or scholars.
- The fitting analysis component for the learning process of students. —is made by educators and scholars.
- The database component for storing the media objects and instruction materials. —is implemented by art designers or computer workers, and is managed by computer engineers.

3.2 Three-layer CAI architecture

From the CAI system described with UML shown in Fig.3, we can know that the course and exam component is the most important one and the other components are discussed in other area. In our system, we propose the Multi-layer CAI architecture to construct the CAI systems, and use the management of components to distribute the resources over the servers on Internet to achieve the goal of resource sharing.

We present a 3-layer CAI architecture model that expresses different points of view and is fully flexible and component oriented [2,3]. Based on the efficiency of systems, the model is partitioned into 3 layers--resource layer, presentation layer and evaluation layer. It raises the productivity of system development and improvement process, also promotes the individual skills and development of distributed computing environment.

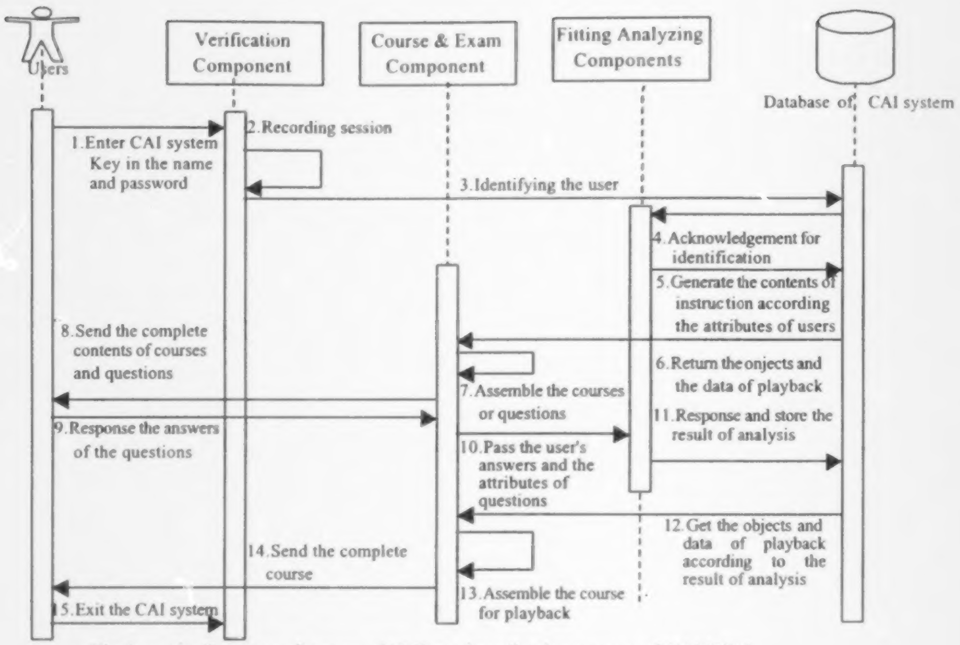

Users
Verification Component
Course & Exam Component
Fitting Analyzing Components
Database of CAI system
1.Enter CAI system Key in the name and password
2.Recording session
3.Identifying the user
4.Acknowledgement for identification
5.Generate the contents of instruction according the attributes of users
6.Return the onjects and the data of playback
7.Assemble the courses or questions
8.Send the complete contents of courses and questions
9.Response the answers of the questions
10.Pass the user's answers and the attributes of questions
11.Response and store the result of analysis
12.Get the objects and data of playback according to the result of analysis
13.Assemble the course for playback
14.Send the complete course
15.Exit the CAI system

Fig.3 use the Sequence diagram of UML to describe the process of CAI [8][9]

3.3 Relationship between Three-layer CAI architecture and hypermedia

From the Table 1 and the frame and resource objects defined in our multimedia presentation system, we can analyze that to what layer the settings of various objects belong listed in Table 2[2][4]. In the components of scenario, we define the miFi that describes which frame should be displayed after the message is triggered, i.e. we can use the expressions to define the schedule of playback of the frames about designing exams and teaching. The components of plot or story just describe the flow of teaching courses defined by users.

From Table 3, we can design and implement the system on Internet more easily to let teachers or other education experts design their teaching materials or questions of exams conveniently and systematically.

4 Conclusion

Different researchers can benefit from this architecture by studying their own knowledge domain independently. Shortening the time spent on completely developing the whole system is to promote the successful rate of resolving the kernel problems. Researchers can' t benefit from studying their own domain only; it's necessary for them to know our open architecture that can easily expand one system into various domains.

Users can acquire an easy-used and reusable system from defining components of multimedia and instructive units of CAI. Our architecture lets teachers have the suitable flexibility and lets various experts and scholars participate in the installation of CAI system. The educational authorities can take our architecture as a referenced architecture for developing the multimedia education. Our system is shown in Fig. 4. The prototype of our system has been completely implemented and published in some various conferences or journals. [1] [5] [9] [10]

Table 1. Three-layer CAI architecture [2][4]

Layer	Researcher	Participants
Resource	Researcher of Interface	Designer of animation , graphic, sound
Presentation	Researcher of learning theory	Teacher, Instructor
Evaluation	Researcher of evaluation	Manager, researcher of educational policy

Table 2. Explanation of part of components [2][4]

First layer (Evaluation layer)	
Components of fitting analysis	This component is made according to some theorem. After analyzing the data acquired from the process that the students take exams and learn, there are some various frames generated.
Components of evaluation and analysis	This component is made according to learning evaluation and learning retrieval of theorist or researchers.
Second layer (Presentation layer)	
Components of scenario	This component is made according to the researchers of learning theory or teaching materials.
Components of structure	This component is made according to learning environment.
Third layer (Resource layer)	
Components of exam	This part must include the parameter or properties which is used broadly
Components of background	Background is concerned to the interest and attention of learner.
Components of referents	To help users of different levels from different method and presentation
Components of multimedia	The components make the CAI lively which may be somebody of cartoon

Table 3. Explanations of part of components

Explanation of part of components		Set the values of necessary item needed
First layer (Evaluation layer)	Components of fitting analysis	
	Components of evaluation and analysis	• F_i.O • F_i.Layout and F_i.UM= exam • F.Presentation and F_i.UM= exam
Second layer (Presentation layer)	Components of scenario	• S
	Components of structure	• F_i.Layout and F_i.UM=learn • F.Presentation and F_i.UM=learn
Third layer (Resource layer)	Components of exam	• O_i.UM = exam
	Components of background	• O_i.UM =Background.
	Components of referents	• O_i.UM = Referents

References

[1] Bal Wang , Ching-Fan Chen, Min-Huei Lin. " A Multimedia Presentation System on Web -- Dynamic Homepage Approach"., The Institute of Electronics, Information and Communication Engineers(IEICE) Transactions on Information and System, Vol.E82-D,NO.4,April 1999. pp. [illegible]-736

[2] Min-Huei Lin, Ching-Fan Chen, Ian-Ru Li, " Building Component Oriented Multi-tier CAI Architecture in the Internet ", ICCE' 98 (The Sixth International Conference on Computers in Education) , Beijing,china,1998,pp.180~pp.186.

[3] Bal Wang , Ching-Fan Chen, Min-Huei Lin , Wei-Yu Li , Ya-Ting Chuang. "A Three-Tier Multimedia Presentation System in Internet", ISMIP 98(International Symposium on Multimedia Information Processing),Taiwan, pp. 162-166.

[4] Bal Wang , Ching-Fan Chen, Min-Huei Lin , Ian-Ru Li. "Building multimedia component oriented Multi-tier CAI architecture in the Internet".ISMIP 98(International Symposium on Multimedia Information Processing),Taiwan, pp. 158-161.

[5] Min-Huei Lin, Bal Wang, Ching-Fan Chen, Chien-Ming Pen , Zheng-Kui Huang , Ian-Ru Li. "An Authoring Tool for Teaching Materials on Web- Dynamic Homepage Approach using SMIL". ICCE' 99(International Conference on Computers in Education).

[6] Min-Huei Lin, Chien-Jen Huang, Shang-Zong You, Bal Wang, Ching-Fan Chen ."Using Adjustable Multimedia Homepage Design—A Scheme to Promote the Effect of Web CAI" . ICCE' 99(International Conference on Computers in Education).

[7] Chung, C.-M.; Shih, T.K.; Kuo, C.-H.; Lin, W.-C. . "Supporting the reuse of multimedia presentations" , Information Sciences, Vol: 101, pp. 131-151.

[8] Min-Huei Lin, Zheng-Kui Huang, Bal Wang, , Ching-Fan Chen• "Using Object Oriented Method in Network CAI Model" • The 8th International Conference on Computer-Assisted Instruction.

[9] Min-Huei Lin, Zheng-Kui Huang, Bal Wang , Ching-Fan Chen.• "Management of the Object–Oriented Resources Application System – an Instance of Distance Education" • Distance Education. Vol. 12 , June 1999. pp.53-61.

[10] Bal Wang, , Ching-Fan Chen , Min-Huei Lin , Chien-Ming Pan , Jen-Shan Huang , Hsing-Ten Chein• "An Authoring Tool on Web" • •The 8th International Conference on Computer-Assisted Instruction.

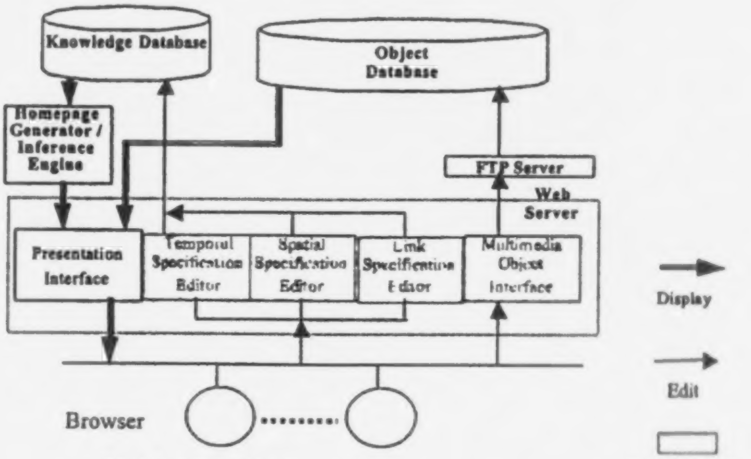

Knowledge Database
Object Database
Homepage Generator / Inference Engine
FTP Server
Web Server
Presentation Interface
Temporal Specification Editor
Spatial Specification Editor
Link Specification Editor
Multimedia Object Interface
Display
Edit
Browser
User Interface

Fig.4. System architecture

CAI System Generator on Web -- using Automatic Trace Recording

Min-Huei Lin, Ching-Fan Chen, Si-Hao Hu, Ming-Hong Taai
and Yung-Hsiang Chiu
Department of Information Management
Aletheia University
Tamsui, Taiwan
R.O.C
Email: lmh@email.au.edu.tw, cfchen@email.au.edu.tw

By the prosperity of computer media, many companies treat electric media as their developmental base and use these electric media in more effective way. It goes without saying that the domain of teaching has developed on the Internet and many CAI systems have been already used in the teaching. The goal of our research is to create CAI systems by automatically recording the trace of editing. So in the thesis, we define the actions of users through image, audio, schedule, point and the module of event, and present the generated CAI systems dynamically on web.

Keywords: **CAI System Generator, Multimedia, Web**

1 The goal

Currently, many teachers and students use CAI systems as their teaching tools, and most teaching materials are designed by both teachers and system engineers. But teachers are generally in the passive position, and if they want to make teaching materials according to their own ideals, they have to learn how to use HTML to design homepages. Usually, students may not understand the meanings of teaching materials very well through the static homepages written in HTML. So we propose and implement an auto-recorded multimedia presentation system to let authors construct dynamic homepages of CAI systems directly through browser on web from automatically recording the trace of their editing.

2 Structure of system

We show the structure of our system in Fig. 1. In the auto-recorded system, we can catch the screen of process of users' operations, or insert sound or image information to the process. Then, these multimedia resources and related information are stored in Information Database and Media Database. The information of presentation schedule is recorded in information database. In the media database, contents of multimedia objects are recorded. In Fig.2, we can see the interactions among Image, Sound, Timer, pointer and Event. Image Module is to make necessary pick-ups for required images, decide what images are picked up in the Event Module Database and store their transition and filename in the forms. Sound Module is used to record sound, thereafter the sounds can be played at proper time by temporal scheduling. Pointer Module is to record the location of mouse pointer. When the transition has something wrong, we can make an adjustment in the coordination. In Timer Module, the time sequences are recorded in the form of Timer Pointer. The schedule designed through directly recording or specified by users is stored in the event database, and the generated multimedia objects will be presented according to the schedule built on the Timer Pointer. Event Module will react to all the other modules. It can decide what modules are going to work, and react to them. When users need to present teaching materials, the Java & HTML Generator will generate and send java code and HTML code to users' browser, then users can see the dynamic homepages. In Fig. 3, we can see a dynamically presented Web CAI system that is produced by recording and modified through the authors' edition and arrangement.

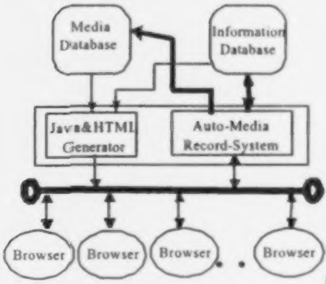

Media Database
Information Database
Java&HTML Generator
Auto-Media Record-System
Browser
Browser
Browser
Browser

Fig.1 Structure of System

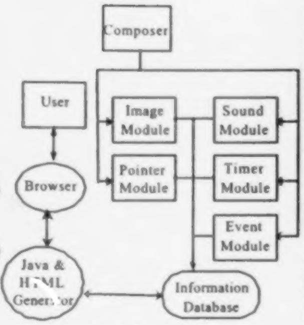

Composer
User
Image Module
Sound Module
Pointer Module
Timer Module
Event Module
Browser
Java & HTML Generator
Information Database

Fig.2 Modules of System

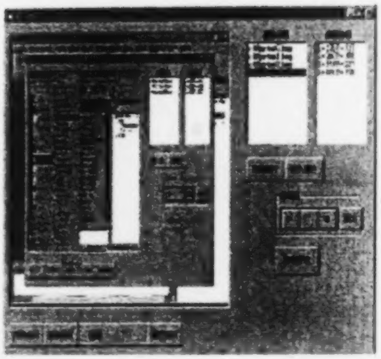


Fig.3 The interface of Auto-Recorded System.

3 Conclusion

We still continuously work on the pack technique of the multimedia file because the transmittance of image and audio are limited by the bandwidth of the Internet. However, teaching through Internet is an inevitable trend in the future, so how to make the best efforts between editing the teaching materials and let the learners learn as efficiently as possible are our goals.

References

[1] Min-Huei Lin, Bal Wang, Ching-Fan Chen, Chien-Ming Pen , Zheng-Kui Huang , Ian-Ru Li. "An Authoring Tool for Teaching Materials on Web- Dynamic Homepage Approach using SMIL". ICCE' 99.

[2] Min-Huei Lin, Chien-Jen Huang, Shang-Zong You, Bal Wang, Ching-Fan Chen ."Using Adjustable Multimedia Homepage Design–A Scheme to Promote the Effect of Web CAI" . ICCE' 99.

[3] James F. Allen "Maintaining Knowledge about Temporal Intervals", Communications of the ACM, Vol. 26, No. 11, 1983.

[4] http://windowsmedia.com

CALL with a Web-based Instructional System in Cooperative Learning Environments

Miwha Lee
Pusan National University of Education
Pusan, Korea
E-mail: mlee@ns.pusan-e.ac.kr

This study developed a Web-based instructional system for computer-assisted language learning (CALL) and examined the effects of ability of the student and group composition on achievement in reading, writing, and listening comprehension in Web-based foreign language learning in a cooperative environment. Forty-four students were randomly assigned to heterogeneous and homogeneous groups. The results of the analysis showed that group composition as well as student ability significantly exerted differential effects on the learning outcomes. The implications of these results for CALL in a Web-based cooperative environment were discussed

Keywords: **Cooperative Learning, Computer-Assisted Language Learning, Web-based Learning**

1 Introduction

1.1 Background of the Study

In recent years, the Internet has been increasingly utilized as an effective instructional tool for language learning, since the Web can become a multimedia-based content provider for both verbal and non-verbal elements of communication with versatility and interconnectedness (Clinch, 1999; Harasim et al., 1996; Khan, 1997; McManus, 1995; Owston, 1997; Ritchie & Hoffman, 1996). Recent studies have shown that the computer as an instructional medium also has the potential for promoting interaction and collaboration among students (e.g., Cates & Goodling, 1997; Cavalier & Klein, 1998; Chen, 1995; Johnson & Johnson, 1996). Computer-assisted language learning (CALL) using a Web-based instructional system can, hence, provide a learning environment that facilitates positive interdependence and collaborative efforts among students. The students work together in small groups at the computer; their efforts are directed toward mutual, academically and socially beneficial, goals. In general, extensive research on cooperative learning has shown profound and positive effects on a wide range of students' cognitive and social-affective outcomes (e.g., Johnson & Johnson, 1999; Johnson et al., 1993; Sharan, 1990; 1994; Slavin, 1995; 1996).

One of the key features that characterize cooperative learning settings and distinguish them from other learning settings is the increased opportunity for interaction among students of diverse ability, beliefs, and value systems in the learning process. Researchers have explored interaction as one of the mediating variables in the relationship between cooperative learning and social and academic gains (Hettinger, 1995; Huang, 1995; Sharan, 1990; Webb, 1989). Hence, in a cooperative learning environment, students are typically grouped heterogeneously. The rationale for heterogeneous grouping is based on the assumption that students can encounter wider diversity in heterogeneous groups than in homogeneous groups. Of particular interest in this study are the ability of the student and group composition. Although research indicates that both high- and low-ability students gain social benefits by working in heterogeneous groups, the cognitive effects of ability grouping, heterogeneous or homogeneous, have been inconclusive (e.g., Cavalier & Klein, 1998; Huang, 1995; Mevarech et al., 1991; Webb, 1989; Webb & Lewis, 1988).

1.2 The Purpose of the Study

The purpose of this study was to examine the effects of student ability and the influence of heterogeneous and homogeneous group composition on achievement in reading, writing, and listening comprehension in computer-assisted foreign language learning with a Web-based instructional system in a cooperative learning environment. The achievement in reading, writing, and listening comprehension of high- and low-ability students were compared in heterogeneous and homogeneous groups featuring individual and group accountability.

2 Method

2.1 Subjects

The subjects were 44 undergraduate students enrolled in a required one-semester foreign language course at a university in a metropolitan city in Korea. All the subjects had some previous experience with computers (e.g., word processing, Internet, telecommunications, games, and/or programming). All students had taken English as a first foreign language and French, German, Chinese, or Japanese as a second foreign language in middle and high schools

2.2 A Web-based Instructional System

For the purpose of this study, a Web-based instructional system was designed and developed for French language learning. This instructional system appears to be one of the first Web-based instructional systems for computer-assisted French language learning in Korea. The instructional system was designed to be adaptive to individual learning situations on a non real-time basis. Students can navigate the hyperlinked multimedia contents without a pre-ordered learning schedule. Through their exploration and navigation, thus, they can design their own instruction. The contents of the instructional system are divided into two levels: beginning and advanced. Each level consists of 15 coherent but independent lessons. As shown in Figure 1, each lesson is composed of six sections: reading, writing, listening, speaking, grammar, and games.

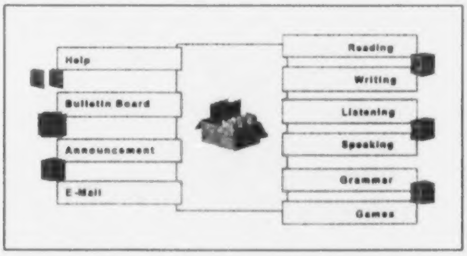


Figure1. Web-based instructional system for CALL

The reading section shows paragraphs in a variety of styles and includes interpretations and in-depth explanations regarding morphological, lexical, syntactical and semantic-pragmatic rules and expressions used in each sentence. The writing section enables students to gain pragmatic competence in their writing skills. It provides questions related to context-based composition. The listening section presents simple expressions with immediate text feedback to improve students' listening comprehension. The speaking section is designed with an emphasis on conversational practice, based on given situations presented as a picture. Concerning the grammatical rules of the previously presented sentences, the grammar section provides charts, pictures, and examples as well as explanations about those points. The game section is an additional unit designed to motivate students through games, songs, or puzzles, which may not deal with the lesson directly.

The instructional system also includes the interactive facilities: help, bulletin board, announcements, and e-mail. The help component includes general instructions regarding the system. The bulletin board deals with management-related interactions such as a school calender and logistics. The announcements show FAQ's (Frequently Asked Questions) on subject materials or technical problems. The e-mail allows for individual communications. These interaction facilities were designed to provide various types of asynchronous communications among three different user groups: teachers or tutors, students, and system administrators.

In designing and developing the user interface of the instructional system, a special emphasis was placed on user-friendliness and efficiency. A simple, intuitive design with a text -based menu, rather than a complicated design, was preferred. In addition, the instructional system utilizes well-designed TrueType fonts, which support Unicodes such as 'Lucida Sans Unicode,' 'Berdana,' and 'Times New Roman.' The basic color of the instructional system was carefully selected based on color-effectiveness studies (Moore, 1996; Pett & Wilson, 1996; Weinman & Heavin, 1996). Given current access speed to the Internet via modems or LANs (Local Area Networks) in schools, a minimum level of animation was used in order not to interfere with students' concentration level in the learning process (Jeong & Yoon, 1998). For consistent and systematic delivery of information, any subsequent hyperlinked information is presented on the same page. To this end, the interface was developed using Active Server Page (Hillier & Mezick, 1998) and Dynamic-HTML (HyperText Markup Language) (Homer, 1997).

2.3 Procedure

Before the study began, students were asked to complete a background survey, which was given in order to assess students' previous experience with computers and language learning and to provide a better description of the subjects. A pretest was administered to all students to identify those with high or low ability. Stratified random sampling was used to assign students to heterogeneous and homogeneous ability groups. Heterogeneous ability groups contained one high-ability student and one low-ability student. Homogeneous ability groups contained two high-ability students or two low-ability students. Students were unaware of the ability composition of the group. Students then received an overview of the Web-based instructional system and instruction for cooperative work. They were instructed to work cooperatively as a group on the task, to help each other learn, and to make group decisions on the course of their actions in the learning process. Students were not assigned specific roles within a group, nor were they allowed to divide the work. Students worked for 50 minutes each day, 2 days each week, for 15 weeks, a total of 30 instructional sessions for one semester.

2.4 Research Design and Data Analysis

The study employed a 2 x 2 factorial design. The between-subjects factors included Ability (high, low) and Group Composition (heterogeneous, homogeneous). The within-subjects factors included Achievement Scores of Reading, Writing, and Listening Comprehension. The analysis of variance (ANOVA) was performed to determine the interaction effects as well as the main effects of ability and group composition on achievement in reading, writing, and listening comprehension. The analysis of covariance (ANCOVA) was also conducted, with students' previous experience with computers and the pretest results serving as the covariates. The level of significance was set at .05 in this study.

3 Results

The means and standard deviations for achievement in reading, writing, and listening comprehension are presented in Table 1. The results of the analysis of variance for achievement scores by ability and group composition are shown in Table 2.[1]

---

[1] It should be noted that students' previous experience with computers and the pretest results did not significantly correlate with the achievement scores. The results of ANCOVA rarely differed. Hence, for the purpose of clarity, the results of ANOVA are presented in this section.

Table1. Means and Standard Deviations of the Achievement Scores by Ability and Group Composition

		Reading	Writing	Listening	Total
Ability					
High	M	8.39	8.22	5.43	22.04
	SD	1.23	2.13	2.43	4.76
Low	M	7.38	7.00	4.43	18.81
	SD	1.94	2.55	2.06	5.54
Group Composition					
Heterogeneous	M	8.64	8.27	5.18	22.09
	SD	1.33	2.19	2.42	5.26
Homogeneous	M	7.18	7.00	4.73	18.91
	SD	1.68	2.47	2.19	5.04
Total	M	7.91	7.64	4.95	20.50
	SD	1.67	2.39	2.29	5.34

3.1 Reading

Significant main effects were found for Ability, F (1, 40) = 7.208, $p < .05$, and for Group Composition, F (1, 40) = 14.029, $p < .05$, and significant interaction effects were also found for Ability and Group Composition, F (1, 40) = 7.268, $p < .05$. These results indicate that student ability and group composition exerted differential effects on achievement in the reading posttest, as shown in Tables 1 and 2. High- and low-ability students tended to achieve differentially across the groups of different composition on the reading posttest. The students in heterogeneous groups scored higher than did those in homogeneous groups. This pattern is more noticeable among low-ability students than high-ability students.

3.2 Writing

As shown in Table 2, there were significant main effects for Group Composition, F (1, 40) = 4.401, $p < .05$, and significant interaction effects for Ability and Group Composition, F (1, 40) = 3.759, $p < .05$. Yet, main effects for Ability were not statistically significant. Both high-ability and low-ability students working in heterogeneous groups tended to score higher on the writing posttest than did those working in homogeneous groups. These results indicate that the achievement of high-ability and low-ability students was dependent on the group composition in which they were working.

3.3 Listening Comprehension

No significant effects were found for Ability or Group Composition or for the interaction between Ability and Group Composition. The results indicate that the differences between the posttest means were not statistically significant, probably due to the relatively large standard deviations, as shown in Table 1.

Table 2. ANOVA Results for the Achievement Scores by Ability and Group Composition

	Source of Variation	Sum of Squares	DF	Mean Squares	F	*P*
Reading	Ability	12.750	1	12.750	7.208	.011
	Group Composition	24.817	1	24.817	14.029	.001
	Interactions	12.856	1	12.856	7.268	.010
Writing	Ability	17.892	1	17.892	3.719	.056
	Group Composition	19.442	1	19.442	4.401	.046
	Interactions	18.041	1	18.041	3.759	.050
Listening	Ability	11.600	1	11.600	2.316	.136
	Group Composition	2.759	1	2.759	0.551	.462
	Interactions	11.697	1	11.697	2.335	.134
Total	Ability	125.586	1	125.586	5.818	.021
	Group Composition	122.144	1	22.144	5.659	.022
	Interactions	126.632	1	26.632	5.867	.020

4 Conclusion

This study examined the effects of student ability and group composition on achievement in reading, writing, and listening comprehension in computer-assisted foreign language learning with a Web-based instructional system in a cooperative learning environment. The results of the analysis of variance indicate that group composition as well as student ability significantly exerted differential effects on the learning outcomes. Both high-ability and low-ability students working in heterogeneous groups showed higher achievement than did those working in homogeneous groups. These results corroborate and lend further support to the findings of the previous studies, that heterogeneous group composition benefits students of both high ability and low ability (Larson et al., 1984, Webb, 1982a; 1982b; Yager, 1986). The cooperative learning methods, in non-computer settings, often call for students to be grouped heterogeneously by ability (e.g., Sharan, 1994; Slavin, 1995). The findings of this study suggest that ability grouping can also be utilized as an effective and practical method in Web-based instructional settings

Suggestions for future research should be noted. First, a comparative study of group learning with individualized learning in Web-based instructional settings may be worth further investigation. Second, this study employed pairs; the findings may not apply to larger groups. Some research suggests the importance of group size as well as group composition in computer-based cooperative learning (Guntermann & Tovar, 1987). Finally, this study has focused on the product of group learning. Future research should also analyze the intra-group dynamics among students in the learning process.

References

[1] Cates, W. M. & Goodling, S. C. (1997). The relative effectiveness of learning options in multimedia computer-based fifth-grade spelling instruction. *Educational Technology Research and Development*, 45(2), 27-46.

[2] Cavalier, J. C. & Klein, J. D. (1998). Effects of cooperative versus individual learning and orienting activities during computer-based instruction. *Educational Technology Research and Development*, 46(1), 5-18.

[3] Chen, M. (1995). A methodology for characterizing computer-based learning environment. *Instructional Science*, 23, 183-220.

[4] Clinch, B. J. (1999). Web-assisted language learning. *Proceedings of Ed-Media 99*, Seattle, WA. 1334-1335.

[5] Guntermann, E. & Tovar, M. (1987). Collaborative problem solving with Logo: Effects of group size and group composition. *Journal of Educational Computing Research*, 3, 313-334.

[6] Harasim, L., Hiltz, S., Teles, L., & Turoff, M. (1996). *Learning networks*. Cambridge, MA: MIT Press.

[7] Hettinger, G. (1995). Raising the level of the debate: The effects of computer-mediated communication on group dynamics and critical thinking skills. *Proceedings of AECT*, 186-193.

[8] Hillier, S. & Mezick, D. (1998). *Inside programming Active Server Pages*. Redmond, WA: Microsoft Press.

[9] Homer, A. (1997). *Instant IE4 dynamic HTML: Programmer's reference*. Birmingham: Wrox Press.

[10] Huang, J. C. (1995). Effects of types of feedback on achievement and attitude during computer-based cooperative condition. *Proceedings of AECT*, 219-226.

[11] Jeong, H. & Yoon, A. (1998). Interface design of electronic -dictionary developing system: Considering end-user's knowledge. *Proceedings of '98 HCI*, 18-20.

[12] Johnson, D. W. & Johnson, R. T. (1996). Cooperation and the use of technology. In Jonassen, D. H. (Ed.). *Handbook of research for educational communications and technology*. New York: Simon & Schuster Macmillan.

[13] Johnson, D. W. & Johnson, R. T. (1999). *Learning together and alone: Cooperation, competition, and individualistic learning*. (5th Ed.). Needham Heights, MA: Allyn & Bacon.

[14] Johnson, D. W., Johnson, R. T., Holubec, E. J., & Roy, P. (1993). *Circles of learning: Cooperation in the classroom*. (4th Ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

[15] Khan, B. H. (Ed.). (1997). *Web-based instruction*. Englewood Cliffs. NJ: Educational Technology Publications.

[16] Larson, C. O., Dansereau, D. F., O Donnell, A., Hythecker, V., Lambiotte, F. G., & Rocklin, T. R. (1984). Verbal ability and cooperative learning: Transfer of effect. *Journal of Reading Behavior*, 16, 289-295.

[17] McManus, T. (1995). Special considerations for designing Internet-based education. In. D. Willis, B. Robin & J. Willis (Eds.). *Technology and Teacher Education Annual*. Charlottesville, VA: Association for Advancement of Computing in Education.

[18] Mevarech, Z. R., Silber, O., & Fine, D. (1991). Learning with computers in small groups: Cognitive and affective outcomes. *Journal of Educational Computing Research*, 7(2), 233-243.

[19] Moore, F. C. (1996). The do's & don'ts of web site design. [On-line]. http://www.webspertise.com/.

[20] Owston, R. D. (1997). The World Wide Web: A technology to enhance teaching and learning. *Educational Researcher, 26(2)*, 27-33.

[21] Pett, D. & Wilson, T. (1996). Color research and its application to the design of instructional materials. *Educational Technology Research and Development*, 44(3), 19-35.

[22] Ritchie, D.C. & Hoffman, B. (1996). Using instructional design principle to amplify learning on the World Wide Web. [On-line]. http://www.edweb.sdsu.edu/.

[23] Sharan, S. (1990). *Cooperative learning*. New York: Praeger.

[24] Sharan, S. (Ed.). (1994). *Handbook of cooperative learning methods*. New York: Greenwood Publishing.

[25] Slavin, R. E. (1995). *Cooperative learning: Theory, Research, and Practice*. (2nd Ed.). Englewood Cliffs, NJ: Prentice- Hall.

[26] Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology*, 21, 43-69.

[27] Webb, N. M. (1982a). Peer interaction and learning in small cooperative groups. *Journal of Educational Psychology*, 74, 642-655.

[28] Webb, N. M. (1982b). Group composition, group interaction, and achievement in cooperative small groups. *Journal of Educational Psychology*, 74, 475-484.

[29] Webb, N. M. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research*, 13(1), 21-39.

[30] Webb, N. M. & Lewis, S. (1988). The social context of learning computer programming. In R. E. Mayer (Ed.), *Teaching and learning computer programming*. Hillsdale, NJ: Lawrence Erlbaum.

[31] Weinman, L. & Heavin, B. (1996). *Coloring Web Graphics*. New York: New Riders.

[32] Yager, S., Johnson, D. W., Johnson, R. T., & Snider, B. (1986). The impact of group processing on achievement in cooperative learning groups. *Journal of Social Psychology*, 126, 389-397.

CBR-TUTOR: A Case-Based Reasoning Approach to an Internet Agent-based Tutoring System

Rhodora L. Reyes and Raymund Sison
ccsrlr@ccs.dlsu.edu.ph, ccsrcs@ccs.dlsu.edu.ph
College of Computer Studies, De La Salle University. Professional Schools Inc.
Manila, Philippines

Providing individualized instruction is an important tutoring task. Different learners have different needs. This task becomes more important when dealing with learners on the web. This paper presents the CBR-TUTOR, an Internet-based tutoring agent system that uses case-based reasoning approach in providing adaptive instruction to its learners. Using CBR in the tutor model enables the tutor to reference from past experiences and identify which instructional strategies were successful given a similar situation or student characteristics. The CBR-TUTOR is designed as a distributed problem solving architecture where each agent performs decision-making tasks and cooperates to help improve the effectivity of the tutoring system.

Keywords: **Intelligent Tutoring Systems, Case-Based Reasoning, Web-based learning, Agents**

1 Introduction

"The Internet now provides a possible new dimension to information technology in education, not only in terms of potential as a vast information resource, but also in respect of interaction and knowledge construction between individuals" (Wood, 1999). Unfortunately, most of the learning systems and electronic textbooks accessible on the web lack the capabilities of individualized instruction and user-adapted learning support that are emergent features of Web-based Intelligent Tutoring Systems [10].In providing individualized instruction, it is important to diagnose the problems of individual learners and identify how to adapt instruction and remediation to the needs of the individual learner. The diagnosis of the learner often involves analysis of learner errors. This is the task of the student model component of an Intelligent Tutoring System (ITS). A student model is an approximate representation of a student' s knowledge about a particular domain, which accounts for the students' solutions to given problems [9]. The tutor model component of an ITS, on the other hand, uses the student model to determine how to provide instruction and remediation [6].

The tutor model must be able to recognize the similarity and differences in the needs of these learners. Different learners have different needs. The task becomes more important when dealing with students on the web. Therefore, Internet-based tutoring systems must be able to reference to past experience in order for it to know which approach will be appropriate given a situation (or case). However, no past situation is ever exactly the same as a new one and domain knowledge for instructional strategies is oftentimes incomplete. This makes the tutor model incapable of using the instructional method appropriate to the learner. It is therefore necessary to create a tutor model that has the capability to understand new situations in terms of old experiences and adapt an old solution to fit a new situation. Cased-Based Reasoning (CBR) suggests a model of reasoning that incorporates problem solving, understanding, and learning; and integrates all with memory processes. CBR can mean adapting old solutions to meet new demands, using old cases to critique new solutions or reasoning from precedents to interpret a new situation or create an equitable solution to a new problem. [5]. CBR cycle has four phases: *retrieving* the most similar case or cases, *reusing* the information and knowledge in the case to solve the problem, *revising* the proposed solution and *retaining* the parts of the experience that is likely to be useful for future problem solving [2].

Using CBR in the tutor model enables the tutor to reference from past experiences and identify which instructional strategies where successful given a similar situation or student characteristics. Existing

Case-based Intelligent Tutoring Systems use cases for teaching the learners the domain, that is, they use cases as pedagogy similar to the way exercises are used as strategy for teaching. Examples of such systems are Case-based Intelligent Tutoring Systems for operators of dynamic systems (CB-ITS) [3], Georgia Tech Case-Based Intelligent Tutoring Systems for Pilots (GT-CBITS) and Case-Based Reasoning Approach to Simulation-Based Intelligent Tutoring Systems for Tactical Action Officers (TAO ITS) [7]. However, none of these systems use CBR as an approach in helping the tutor identify similar experiences encountered when providing individualized instruction to the learners.

CBR-TUTOR is an Internet agent-based tutoring system that uses the CBR approach in providing adaptive instruction to its learners. It is designed as a distributed problem solving architecture where each agent performs decision-making tasks and *cooperates* to help improve the effectivity of the tutoring system. Cooperative agents are agents that are assigned to do specialized tasks to solve a common goal. Section 2 of this paper discusses the architecture of CBR-TUTOR followed by the discussions of its components in Section 3. Finally, the conclusion and future works will be presented.

2 CBR-Tutor Architecture

CBR-TUTOR is an Internet-based tutoring agent system that uses case-based reasoning (CBR) approach to determine how to provide individualized instruction to its learners. This section discusses the architecture of the CBR-TUTOR in terms of its components and their relationships.

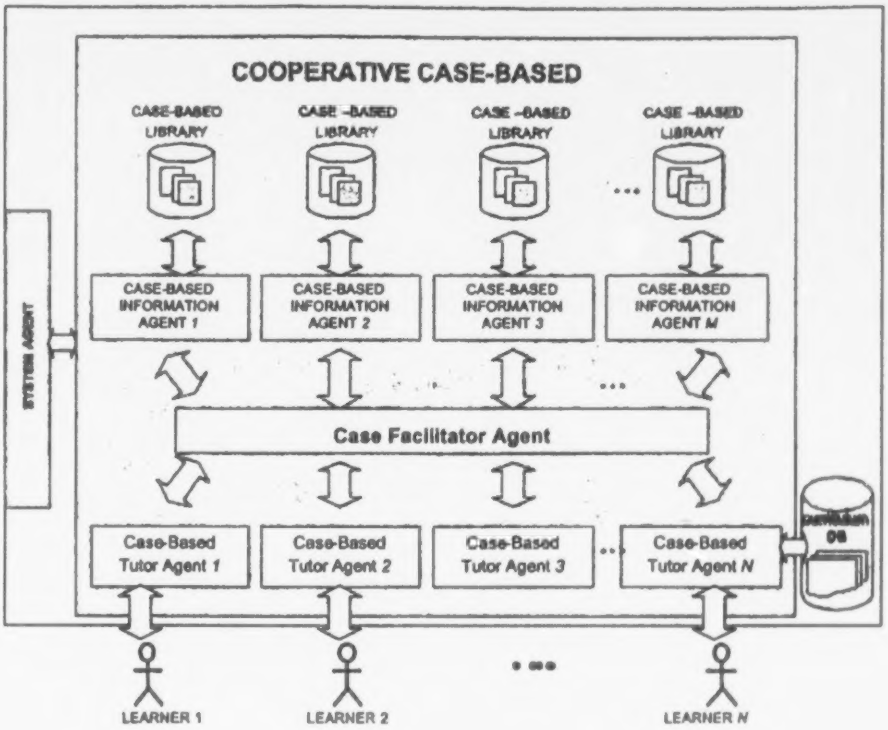
CBR-TUTOR is a distributed problem solving (DPS) system comprised of the system agent (SA), cooperative case-based module (CCBM) and the curriculum database (CDB). Figure 1 shows the architecture of CBR-TUTOR.

The SA serves as the registry module that contains the complete list of all agents initiated in the system. Whenever there is an unregistered learner (i.e., first time user of the system), the SA initializes the agent (or agents) that will be used for tutoring the learner and informs the CCBM about it. Whenever necessary, the SA also decides if there is a need to process the requests of creation of new agents in the system by CCBM.

The cooperative case-based module (CCBM) is the core component of the CBR-TUTOR. It is composed of cooperating agents designed for actual tutoring of the learners, retrieval, filtering, indexing and learning of cases, and facilitation of requests from different agents in the system. Its sub-components are case-based tutor agents (CTAs), case facilitator agent (CFA), case-based information agents (CIAs), and case-based libraries (CBLs). The CTAs are the actual tutors assigned to the learners while CIAs are agents whose tasks are to retrieve, filter, index and modify (or learn) cases in its CBL. A CBL contains the set of cases used in the system. Discussion of the CCBM components is discussed in detail at section 3.2.

Depending on the planned teaching activities, a CTA accesses the curriculum database (CDB) for content presentations. These presentations include the lessons, examples, elaboration, exercises, answers, definitions and descriptions.

Figure 1. The CBR-TUTOR Architecture


COOPERATIVE CASE-BASED
CASE-BASED LIBRARY
CASE -BASED LIBRARY
CASE -BASED LIBRARY
CASE -BASED LIBRARY
CASE-BASED INFORMATION AGENT 1
CASE-BASED INFORMATION AGENT 2
CASE-BASED INFORMATION AGENT 3
CASE-BASED INFORMATION AGENT M
SYSTEM AGENT
Case Facilitator Agent
Case-Based Tutor Agent 1
Case-Based Tutor Agent 2
Case-Based Tutor Agent 3
Case-Based Tutor Agent N
Curriculum DB
LEARNER 1
LEARNER 2
LEARNER N

3 CBR-Tutor Components

The primary components of the CBR-TUTOR are its specially designed agents. These are COOPERATIVE CASE-BASED MODULE (CCBM) and SYSTEM AGENT (SA). This section discusses the detailed discussion of these components.

3.1 Cooperative Case-Based Module

The COOPERATIVE CASE-BASED MODULE (CCBM) is the heart of the CBR-TUTOR. It is composed of specialized agents that have specific decision-making task that cooperates to help provide individualized and adaptive instruction using the case-based reasoning approach. The major components of CCBM are CASE-BASED TUTOR AGENTS, CASE FACILITATOR AGENT, CASE-BASED INFORMATION AGENTS and CASE-BASED LIBRARIES, as illustrated in Figure 1.

3.1.1. Case-Based Tutor Agent

The CASE-BASED TUTOR AGENT (CTA) interacts directly with the learner. It creates a profile of its learner (i.e., learner type, lessons taken, performance, strategies applied, output from *external student modeling system*, etc.) and this information for evaluating the current scenario. (i.e., case). The CTA uses the case-based reasoning approach in planning for the teaching strategy to use, with the help of the other agents in CCBM.

The CTA has four components: INTERFACE, CASE-BASED MODULE, INSTRUCTIONAL PLANNER, and STUDENT KNOWLEDGE BASE, as shown in Figure 2.

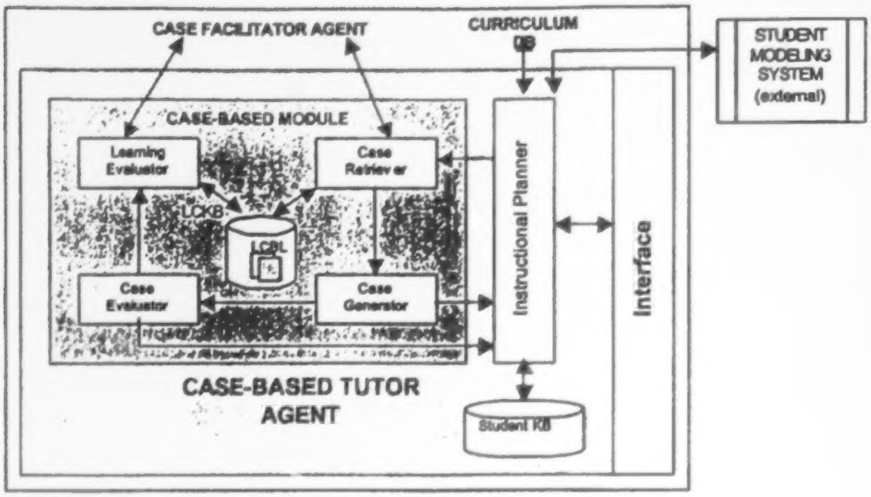


Figure 2. Components of a Case-Based Tutor Agent (CTA)

All communications between the CTA and the learner is done through the *interface*. The *interface* is designed as a *web-based interface* for simplicity and universal access. The system can be used through standard browsers.

The INSTRUCTIONAL PLANNER (IP) is the component of the CTA that assesses the current case (i.e., current teaching scenario), and communicates with the interface and the CASE-BASED MODULE (CBM). Based on the current case, the IP forwards its requests to the CBM for generation of helpful case (or cases). The proposed solution (i.e., result of the request) from the CBM is implemented by the IP. Implementation of the proposed solution requires the generation of content presentation. The IP does this by accessing the CURRICULUM DATABASE (CDB), which contains the lessons, exercises, examples, description, elaboration, answers and definitions.

The IP is also responsible for updating the STUDENT KNOWLEDGE BASE (SKB). The SKB contains information about the user including the name, password, identification number, and student type (i.e., low, medium, high). It also contains the result of the diagnoses of the *external* student modeling system, lessons taken, and performance evaluation of the leaner.

The component of the CTA that uses the Case-Based Reasoning (CBR) approach is the CBM. The CBM' s tasks are to retrieve useful case (or set of cases), propose a solution (i.e., teaching plan), test and evaluate the proposed solution, and if needed, learn a new case. The CBM keeps local copies of cases that are frequently used during the tutoring sessions and stores it in the LOCAL CASE-BASED LIBRARY (LCBL). CBM also has a CASE RETRIEVER module, which retrieves cases from the LCBL and/or requests for cases through the CASE FACILITATOR AGENT (CFA). The retrieval approach used by the CASE RETRIEVER is the same as the retrieval approach used by the CIA (discussed in section 3.2.3.). The CASE RETRIEVER, depending on its *certainty factor*, decides whether to request for case retrieval through the CFA or use only the retrieved cases from the LCKB. The *certainty factor* is a measure used to evaluate the appropriateness or availability of cases in the LCBL. If the CTA does not have enough cases to solve the current case, it makes a request to the CFA for retrieval of *good* cases. *Good cases* are those that have potential to make relevant prediction about the new case [4]. This means that cases retrieved either helps the CTA achieve a goal or warns about the possibility of a failure or point out an unforeseen problem [5].

The cases retrieved (or requested) by the CASE RETRIEVER is given to the CASE GENERATOR, which in turn checks which of the retrieved case matches exactly the retrieved case. In the event of finding an exact match, the CASE GENERATOR proposes a solution based on the retrieved case and forwards it to the IP for *reuse*. However, it is seldom that previous case matches the current case exactly. It is therefore necessary for the CASE GENERATOR to revise the retrieved case and propose a new solution. The *proposed new solution* is tested and, if needed, repaired by the CASE EVALUATOR until a *confirmed solution* has been achieved. The *confirmed solution* is then forwarded to the IP for implementation. The CASE EVALUATOR also forwards the *confirmed solution* to the LEARNING EVALUATOR for possible learning of the new case. If there is a need to learn a new case, the LEARNING EVALUATOR updates the LCBL and informs the CASE RETRIEVER about the changes in the LCBL. The approach for learning a new case (i.e., case library update) used by the learning evaluator is the same as the approach used by the CIA (discussed in section 3.2.3.). The LEARNING EVALUATOR also informs the CFA that a new case has been learned.

3.1.2 CASE FACILITATOR AGENT

The case facilitator agent (CFA) serves as mediator between the case-based tutoring agents (CTAs) and the case-based information agents (CIAs). This means that the CFA performs matchmaking of services thatcan be provided by CIAs and requests made by CTAs. The CFA tracks all requests for retrieval of cases and monitors the updating (i.e., learning) of new cases. It receives requests from CTAs, sends these requests to the candidate CIA (or CIAs) and returns responses to the requesting CTAs. The CFA has two major components: service request module, and agent information manager (see Figure 3).

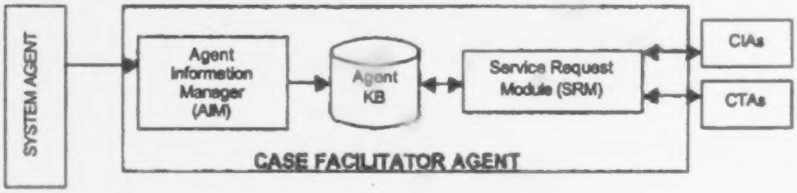


Figure 3. Components of the Case Facilitator Agent

The SERVICE REQUEST MODULE (SRM) supervises all requests from the CTAs. There are two types of requests: retrieval of cases and updating (learning) of new cases. Using the *knowledge* about the capabilities of the CIAs, the SRM performs matchmaking and assesses which CIAs are suitable to process the request. This knowledge includes the *indexing vocabulary, specialization* and *taxonomy of indexes* of each CIA. An *indexing vocabulary* is a set of relevant descriptors used to describe and index cases while *specialization* refers to the specific indexes being monitored by the CIA. The *taxonomy of indexes* contains information about the organizational structure of the indexes.

The SRM maps the capabilities of each CIAs to the requests and forwards the requests to the candidate CIAs. The SRM collects the result from all CIAs that responded to the request, checks and eliminates redundant cases before forwarding the result to the requesting CTA.

The AGENT INFORMATION MANAGER (AIM) monitors all the agents registered by the SYSTEM AGENT (SA) in the system. It has the knowledge of the *indexing vocabulary* and *specialization* of each CIA and the CTAs that have been registered. It also supervises the mapping and updating of the taxonomy of indexes. The knowledge about each agent and the taxonomy of indexes are used by the SRM to determine relationships, similarities and differences of the indexes of each CIA. This helps SRM in matchmaking the CTAs request and CIAs capability to process the request.

3.1.3 Case-Based Information Agent

The CASE-BASED INFORMATION AGENT (CIA) performs the tasks of retrieving cases, evaluating and filtering the retrieved cases in the CCBM. Each CIA has an associated CASE-BASED LIBRARY (CBL) for which they are responsible to maintain. Each CIA focuses on particular collection of features (i.e., dimensions) of the case. A *feature* is an attribute-value pair used in the description of the case [5]. This facilitates faster indexing, restructuring, searching and learning of cases. No two CIAs are exactly the same and despite similarities in their structure, they may return different results. A CBL of a CIA may contain cases that are similar to other CBLs (i.e., overlaps) or it may be totally different from the other CBLs .A CIA can also request the SYSTEM AGENT (SA) for *load reallocation* (i.e., creation of a new CIAs), if it is overloaded.

Retrieving Cases

Each CIA uses the combination of searching and matching when retrieving cases. The quality of the search algorithm is closely related to the quality of the organizational structure of the cases. The organizational structure of each CBL is designed, as a *flat library of cases* where cases are stored as simple lists (or array/files). All CIAs who were requested to retrieve cases use the *parallel retrieval approach*. In this approach, each candidate CIA will search for cases and forwards the result to the CFA (if there is any). The CFA will then be responsible for collecting and checking of results for redundancy.

Each CIA uses a SERIAL- SEARCH- PARTIAL- MATCH (SSPM) algorithm (outline shown in Table 1). Since each CIA *specializes* on specific *dimensions* (or set of features), it only searches a relatively small number of cases and searching is not expensive. A *dimension* collectively refers to all descriptive attributes of a case. In the SERIAL SEARCH algorithm, the entire CASE-BASED LIBRARY (CBL) maintained by the CIA is searched. This means that the accuracy of retrieval is a function only of how good the *matching functions* are. The matching function used by a CIA is the PARTIAL- MATCHING FUNCTION. In this approach, cases are indexed using observable features and derived features that capture partial similarities. A *combination of heuristic and numerical evaluation function* is used to compute for the matching and ranking of cases. The *heuristic function* filters cases that had mismatches in important features before comparing cases for their degree of similarity. To measure the degree of match of each pair, the Cognitive System' s (1992), evaluation function is adapted (see Equation 1).

$$\boxed{\frac{\sum_{i=1}^{n} w_i(sim\ (f_i^I, f_i^r)}{\sum_{i=1}^{n} w_i}}$$

Where w_i is the weight of the importance of dimension (slot) *i*, *sim* is the similarity function for f_i^I and f primitives and are the values for the feature f_i in the input and retrieved cases, respectively.

The degree of match is represented as numerical values between 0 to 1. Closer matches have value closer to 1. Similarly, the similarity function with a value closer to 1 means that the features have high degree of similarity.

Equation 1: Evaluation Function

Table 1. Outline of SERIAL SEARCH- PARTIAL MATCHING ALGORITHM (SSPM)

1. For every case in memory, partially match input case:
   - Identify observable features and derived features
   - Compute for the degree of match by using the combination of heuristic and numerical evaluation function. The heuristics identifies the important criteria and then the numeric evaluation function is used for matching and ranking.
2. Return all the best case(s).

Learning Cases

Each candidate CIA decides whether the new case should be learned, and which information from the case to retain, in what form to retain it and how to index the case for later retrieval from similar problems. Learning is a natural consequence of using CBR. It learns by accumulating new cases and indexing the cases properly. A CIA learns basically by applying adaptation (or accumulating generalizations) to the cases and re-indexing of cases that are already in its CASE-BASED LIBRARY (CBL). Re-indexing is done when the case is recalled and it can not be used or it is used but results in failure. When a CIA learns a new case, it informs the CFA of the changes in its *indexing vocabulary* if there is any.

Indexing Cases

The indexing of a case indicates when a case should be retrieved. Cases are indexed based on the goal, solutions method and combinations of descriptors responsible for choice of particular solution. This type of indexing helps the CIA generate a case whenever there is a need to solutions to the current problem (e.g., what will be the strategy given the current case). Cases are indexed by CIAs by adapting the Universal Index Frame [8], which is a generally applicable descriptive vocabulary. UIF covers a broad range of domains about the interactions between agents and its goal.

Load Reallocation

Each CIA also has the capability to request the SA for a creation of a new CIA. When a CIA sees that it is already monitoring a large amount of indexes, using a *load factor*, the CIA can request the SA to divide the load by initializing a new CIA (or set of CIAs). A load is divided according to logical divisions and dimensions of the cases. A *load factor* is a measure of how many indexes a CIA can monitor without affecting the balance of the load of each CIA. The SA will then notify the CFA of the newly created CIA including the knowledge about it, and the changes in the knowledge about the requesting CIA.

3.1.4 Case-Based Library

The *CASE-BASED LIBRARY* (CBL) contains the set of stored cases. Cases represents specific knowledge tied to specific situations, it makes explicit how a task is carried out or how a piece of knowledge was applied or what particular strategies were used for tutoring the learners effectively. The CBL is designed as *flat library of cases* where cases are stored in a simple list. Since each CIA specialized on specific dimension of the case, the CBL is designed to be simple for faster accessing of cases.

Each case in the *CRC* has three major parts: *situation description*, *solution* and *result*. The *situation description* describes the goal (or set of goals), constraints on the goals, and other features of the problem situation. The *solution* part of the case contains the steps used to derive the solution (i.e., tutoring plan of action) and the justifications for decisions that were made. Alternative solutions and/or unacceptable solutions are also included in the *solution* part, if any. Finally, the *result* part of the case contains information about the success or failure of the solution, the explanation for failure or success, the repair strategy and the result of applying the repair.

3.2 System Agent

The SYSTEM AGENT (SA) contains the complete list of all agents initiated in the system. It verifies agent identities and provides their location in the network and transport addresses to the CASE FACILITATOR AGENT (CFA). It also stores additional information about the status of the agent and its type.

The SA communicates directly to the COOPERATIVE CASE-BASED MODULE (CCBM) and performs the following functions:

- Determines if the learner is an unregistered learner, initializes and assigns a CASE-BASED TUTOR AGENT (CTA) for the unregistered learner
- Processes requests from CASE-BASED TUTOR AGENTS(CIAs) for creation of a new CIA
- Monitors the complete list of agents (CTAs and CIAs) in the system and informs the CFA of the status (e.g., newly initialized) and information of these agents.
-

Aside from these functions, the SA is also responsible for all low-level interfaces. These includes access to the operating system or networking services, enforces access rights and privilege security, backs-up and archives pertinent information, and performs exception handling [1].

4 CONCLUSION

This paper presented the architecture of the CBR-TUTOR, an Internet agent-based tutoring system that uses the case-based reasoning approach in tutoring its learners. The architecture is designed such that it can be implemented for different domains (i.e., programming, problem solving, and others) and can be accessed through the Internet. The architecture differs from other internet-based tutoring systems because it utilizes the advantages of using previously experience cases to enhance the tutoring capability of the system. In addition, the CBR-TUTOR architecture is composed of specialized agents that performs the tutoring of learners, facilitation of requests, and filtering, retrieving and learning of new cases. All of these agents cooperate to achieve the goal of providing individualized and adaptive instruction to the learners. The use of agents in the design of this system is increases the effectivity of the tutor to provide adaptive instruction to its learners. Each of the tutoring agent focuses on the individual needs of its learners. Since the system is Internet-based, the use of agents can accommodate more users compared to non-agent-based systems. The other components of the system were also designed as agents because each of these components is autonomous and requires decision-making capability. Future work will focus on the implementation of

CBR-TUTOR in the domain of programming. Further research regarding the learning of cases where the system has the capability to do situation assessment where the reasoner elaborates a situation description to make the description fit the other case library descriptions will also be done.

References

[1] Abadia, L. (1999). A MultiAgent-Based Information Trading Floor Model for an Organizational Intranet.Graduate Thesis. Master of Science in Computer Science, College of Computer Studies, De La Salle University, Manila.

[2] Aamodt, A., Plaza, E. (1994). Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. AI Communications. IOS Press, Vol. 7:1, pp. 39-59

[3] Chappell, A. and Mitchell, C. (1997). The Case-Based Intelligent Tutoring System: An Architecture for Developing and Maintaining Operators Expertise. Proceedings of the 1997 IEEE International Conference on System, Man, and Cybernetics. Orlando, Florida. http://www.chmsr.gatech.edu/publications/smc97/arc/abstract.html. (January 2000).

[4] Dingsoyr, T. (1998) Integration of Data Mining and Case-Based Reasoning. http:/www.idi.ntmu.no/ ~dingsoyr/ diploma/report.html. February 29, 2000.

[5] Kolodner, J. (1993). Case-Based Reasoning. Morgan Kaufmann Publishers, Inc.

[6] Reyes, R. (1999). Adaptive Web-Based Intelligent Tutoring System for C Programming. Proceeding of the 1999 International Conference in Computers in Education. Chiba, Japan.

[7] Row, R. (1995). A Case-based Reasoning Approach to Simulation-Based Intelligent Tutoring Systems and ITS Authoring. http:// www.navysbir.brtc.com/ SuccessStories/StottlerP3.html. (January 2000)

[8] Schank, R., and Osgood, R. 1990. A content theory of memory indexing. Northwester University, Institute for the Learning Sciences Technical Report no. 2.

[9] Sison, R . (2000). Multistrategy Discovery and Detection of Novice Programmer Errors. Machine Learning, 38, 157-180. Kluwer Academic Publishers, Netherlands.

[10] Weber, G. and Specht, M. (1997). User Modeling and Adaptive Navigation Support in WWW-based Tutoring Systems. ELM-ART II. http://www.psychologie.unitrier.de:8000/projects/ELM/Papers/UM97-WEBER.html. (January 2000)

[11] Wood, T. Psychological Access and the Internet (199). Advanced Research in Computers and Communications in Education. G. Cummings et al. (eds.). IOS Press. Pp.973-980.

CedarLearning: The Development of Learner-Centred Environments

Tanya Wilson, Jeanette Muzio, Roger Mundell,
Denise Stockley, and Laureen Vickery
CEDAR, Royal Roads University, 2005 Sooke Road,
Victoria, British Columbia, V9B 5Y2, Canada
tanyawilson@royalroads.ca; jeanette.muzio@royalroads.ca;
roger.mundell@royalroads.ca; denise.stockley@royalroads.ca;
laureen.vickery@royalroads.ca

Royal Roads University (RRU) is a four year old University situated on a 640 acre historic site featuring beautiful grounds and a nineteenth century castle. The mission of the University is to deliver world-class applied and professional programs to Canadian and international adult learners. RRU's degree programs are designed for the mid-career professional and its graduate programs combine periods of on-campus instruction and semesters of distance education. This delivery model (a) aligns with the needs of mid-career professionals, and (b) is dictated by the size of the physical buildings at RRU; currently only 250 learners can be accommodated on-campus at any one time. At RRU's Centre for Economic Development and Applied Research (CEDAR) we have developed tools that allow simultaneously for both knowledge-building, collaborative learning and for individual, self-paced learning in the same course. This flexibility provides the opportunity for just in time and just enough information that creates the truly learner-centred environment. These tools are used in several of the MBA courses, such as finance and e-commerce.

Keywords: **Knowledge Construction and Navigation, Lifelong Learning, Web-Based Learning**

1 Introduction

Royal Roads University (RRU) in British Columbia, Canada is a five year old University situated on a 540 acre historic site featuring beautiful grounds and a nineteenth century castle. For 40 years the facility was used as a campus for Military officers, and became a public University when the Department of National Defense closed the facility and leased the space to the Province of British Columbia.

Although beautiful and steeped in history, The physical facilities limit the on-campus population to only 325 students at any one time. This forced the University to explore alternate delivery methodologies from the very beginning, and has resulted in an innovative and highly effective model that targets mid-career learners.

The University focuses primarily on Masters level programs which are offered at a distance to learners who are still in the workforce and continuing at their jobs. These students come together for a series of brief residencies and complete the remainder of their degree through Web-based distributed learning.

With busy mid-career learners, several issues had to be addressed. In addition to accommodating the usual issues of time and place, the University wanted to adopt a Learner-centred approach that would adjust for such variables as prior learning level; Learning Styles and use of granular knowledge objects. At the same time, designers were cognizant of the significant body of research evidence that points to learning communities and collaborative discourse as critically important components of any online courseware.

The resulting courseware seemed to effectively combine the best of the highly learner-centred techniques used in private sector training with the collaborative techniques that have proven effective in most successful post-secondary online courses.

Using commonly available web development tools the team at Royal Roads University created courses that are database-driven, and use dynamic templates to easily populate and modify course content. They devised a number of online assessment and feedback tools, as well as innovative "jig-saw puzzle" style group assignments to stimulate collaboration. They developed a navigation system to allow learners a choice of delivery styles to suit personal learning style preferences, and a self-assessment mechanism to help learners move through online material on a need-to-know basis.

Additionally, the system provides easy management tools for the instructors to control and modify content, as well as monitor the students' progress, without needing any knowledge of web page creation or HTML.

The development team at Royal Roads University is part of the Centre for Economic Development & Applied Research, (CEDAR). They are continuing to explore and evolve the understanding of what works and what doesn't in online learning. At RRU, the team is fortunate to have a "live" laboratory of more than 900 active online students, and a University-wide commitment to Web-based delivery.

In this presentation, we will demonstrate actual delivered courses, present our findings, and demonstrate our course design. We will show how the use of templates and database driven content allows course designers to adjust for variables of learning style, prior knowledge, and level of effort, in addition to time and place.

CEDAR's methodology is applicable to all forms of electronic distributed learning (EDL) regardless of the delivery mechanism – distance education or classroom delivery, over the Internet or via CD-ROM, instructor-led or instructor-free. Learner-centred EDL courses can be easily designed using commercially available software tools. These tools allow simultaneously for both knowledge-building, collaborative learning and for individual, self-paced learning in the same course. This flexibility provides the opportunity for just in time and just enough information that is demanded by busy professionals seeking a learner-centered environment. These learners have a lifetime of experiences and want a course that is tailored to their needs and takes advantage of their prior knowledge.

Our methodology allows learners to navigate through the content according to learning style. Pre-testing on learning outcomes allows for prior learning assessment, adaptive self-assessment quizzes provide feedback, and technical assistance is built into the course. On-line communities are created through group jigsaw assignments and forum discussions. This allows learners from diverse backgrounds to participate in an on-line environment that is geared to their individual needs.

Some of our unique features include:

1. Learner-centred approach allows learners to navigate throuth the material based on their preferred learning style. This is in contrast to most EDL courses which follow a sequential text-book like approach,
2. Learners can pre-test for prior knowldege. This saves them time as they study only those parts of a course that they do not already know,
3. Self-assessment quizzes allow learners to monitor their progress throughout the course and review as needed,
4. The outcomes-based design of the database allows for the use of shareable courseware objects for different learning needs in different courses.

2 Design and Development of the E-Commerce Course

The development process began with the course designer showing the instructor previously completed courses. By seeing exemplars the instructor was presented with different teaching options that the technology facilitates and allowed the instructor imaginative application of the construction process (integrating real world/live data, interactive diagrams, and animated examples).

The design and development of the e-commerce course was a three-way communication between the content expert, an instructional designer (who is a specialist in learning styles) and the technical designer. The instructor was actively involved in the course development and provided the learning outcomes for the course. The instructional designers established the appropriate navigation for the different Learning Styles and those navigation methodologies were then tagged into the database templates.

The Web based Discussion Forums were setup and the instructor was given early access. The course underwent a period of testing before the students were given access and any noticeable glitches were corrected at that time.

3 Student Engagement

Instructional materials are delivered to distance-learners via the Internet or to classroom-based learners via CD-ROM. The primary thrust behind the methodology was to produce courseware that is truly learner-centred rather than content-driven or instructor-centred. The course material is navigated in a variety of database-driven, learner-selected methods, depending upon individual preferences. Students also have access to a 24-hour online support available for any technical problems that they may experience. PDF files or screen prints are available for offline browsing of the course content.

Each course module has a number of self-assessment questions, which allows the learner to measure themselves against the desired learning outcomes for that granule. A learner may choose to try this assessment before working through any of the material, or afterwards for self-formative evaluation of the module content. At the end of the assessment, the learner is informed which areas of the module require study. Learners returning later to the self-assessment questions are asked questions only on those areas incorrectly answered the first time.

The web application allows the learner to optionally take a learning style test that provides information about their preferred learning style. After completing the test, the individual is provided with information about their preferred style and each unit can be approached according to that style. Users can switch freely between styles at any point.

To enhance critical thinking and process skills, and the development of community, the courses have included:
(a) residency,
(b) group jigsaw assignment,
(c) case-based reasoning,
(d) electronic forums, newsgroups and live chat
(e) peer to peer and self evaluation
(f) real-world, just in time articles for on-line discussion,
(g) instructor acting as a guide on the side and not as a sage on the stage.
(h) Integration of real-world projects.

These opportunities provide for (a) immediate transferability to the workplace, and (b) building a knowledge network that extends long beyond the end of the degree program.

4 Lessons Learned

The results of the project were gathered from learners through formative feedback, summative evaluation, and focus group discussions.

In general, it was found that learners reacted positively to
(a) the different navigation styles for the four learning styles,
(b) the look and feel of the user interface
(c) the on-line technical helps,
(d) the internal consistency of links,
(e) the ability to pre-test prior knowledge,
(f) the on-line immediate feedback given in the self-assessment quizzes
(g) collaborating with their peers at a distance, and jigsaw style assignments.
(h) the flexibility of doing the course at a convenient time and place.

Some learners relied heavily on offline reading of the printed material, particularly those with poor connectivity or minimal familiarity with computers.

Some complained that the course required them to do too much on the computer, and they would have preferred more offline work.

Very technically literate students suggested more use of multimedia in the content. In the finance course, several exercises required the student to use a separate spreadsheet, and it was felt that this functionality should have been incorporated into the online exercise. This can be easily done with the technology that was used.

Some saw the self-assessments as more threatening, (they carried no marks) while most saw them as a tool.

Some suggested allowing the student to mark up the content online, such as with the use of electronic "sticky notes". This suggestion will be implemented in the next course.

Three main lessons that we have learned from this project are:

1. It is possible to produce EDL courseware that is learner-centred and not content-driven or instructor-driven. This results in more satisfied learners who feel that their time, prior knowledge, and learning preferences have been considered,
2. Using off-the-shelf tools save on production time and costs and ensure that tried-and-tested software is utilized,
3. Courses that are database-driven provide opportunities for re-using data elements in different courses.

Computer-Mediated Language learning

Shu Ching Yang
Graduate Institute of Education, National Sun Yat-sen University
shyang@mail.nsysu.edu.tw

1 Introduction

The Web provides a new learning environment with a wealth of pedagogic possibilities. The colorful and visually engaging appearance, rich resources, online audio, video, and other interactive features, combine to make the Web an enormously valuable learning tool. Although it has been argued that web technology has the potential to provide a unique environment for teaching and learning, the psychological implications of its effects on learners' language learning has remained relatively unexplored. The current research does not present much empirical evidence to validate the instructional applications of web technology [1-6]. Furthermore, results of a meta-analytical study, Ayersman found that perceptions and attitudes toward technology are functionally important in promoting effective learning [7]. Therefore, more research needs to be conducted into learners' perceptions toward this new technology so specific guidelines for its successful implementation can be provided.

This study looked at learners' attitudes and perceptions as they conducted technology-augmented projects, and asked what were their affective attitudes and cognitive perceptions toward this tool. The study contributes to an understanding of language learning using the Web, and provides a basis for empirical studies of Taiwanese EFL learners performing real educational tasks with the Web. The insights gained in this small study will help EFL teachers design better learning environments with regard to classroom management, assessment and assignment.

2 Methodology

Participants

The 55 participants in this study were second year students, majoring in Applied English at a junior college. They had taken a 2-credit required course in Tourism English for two semesters.

Web-based Language Project

The goal of this project was to apply the language that the students had learned in an authentic context, to communicate, and to nurture students' global perspectives and information literacy. The project aimed to help students understand the Web with the ultimate goal of using it to create research projects about selected states in the U.S. Specifically, the objectives for the project were to: (1) provide students with background information about American culture, its separate states, cities, food, customs, people, history, travel information, etc. (2) provide students with an information-literate experience in web technology; (3) enhance students' discourse synthesis ability, namely, learning how to search, organize, and compose information for a research project. Students were asked to work on conducting a search of an assigned American state on the Web. Students could create their projects in whatever format they would like.

Instruments

A questionnaire was given to elicit relevant information on the participants' perception of, and attitudes towards, using the Web to complete their Web-based English projects. The first part of the survey pertained to background information. The second part consisted of 40 attitude and perception statements about learning experiences indicating levels of agreement or disagreement on a 5-point Likert-type scale with 5 standing for strong agreement. The Cronbach coefficient alpha of the survey was .87, suggesting the internal reliability to be quite acceptable. The third part included open-ended questions depicting their reflections about the project.

Data Collection and Analysis

After data collection, the quantitative and qualitative methods were performed. The qualitative analysis made from the student responses to the open-ended questions and the researcher' s observation, provided the opportunity to uncover deeper issues than might have been apparent in a quantitative study. Results from the factor analysis (principal axis factoring with varimax rotation) yielded six factors accounting for 64.11 percent of the variance. Following are the interpretations of each factor: cognitive disorientation, learning anxiety, perceived enhancement of language ability, perceived enhancement of cultural understanding, as well as the Web as a potentially useful search tool, and the overall perception of language learning on the Web.

3 Discussion and Conclusion

The study investigated second-year junior college students' attitudes and perceptions towards the web as an educational resource. Six main factors concerning the learners' perceptions were identified, including cognitive disorientation, learning anxiety, perceived enhancement of language ability, perceived enhancement of cultural understanding, as well as the Web as a potentially useful search tool, and the overall perception of language learning on the Web. The study showed that the reaction of students to technology-augmented assignments was mixed. Analysis of the survey revealed a generally positive attitude towards the project pertaining to the enhacement of cultural awarenss and overall language learning. A few negative responses were noted, as learners experienced varying degrees of disorientation and cognitive overload. In particular, those learners who do not adjust well to reading on the Web appear to have much learning anxiety and cognitive disorientation, and correspondingly, have a lower overall perception of language learning.

Some frustration with the challenges and difficulties in relation to computers and language were found. On the one hand, students' encountered technical difficulties in relation to the use of computers. The problems they encountered were; malfunctioning of the system, the periodic slowness of Internet connections, poor design of web documents, searching complications, time constraints and the inconvenience of being required to work on the project on campus. On the other hand, students commented on the challenges of reading, selecting, processing and evaluating information. For example, some learners had not developed effective searching strategies for locating appropriate information and, further made qualitative judgments as to the accuracy and reliability of specific information. Given the fact that interest is the impetus of learning, and method is the key to knowledge, teachers should inform learners of effective learning strategies and design diversified learning enviroments by providing intellectual, entertaining and interesting assignmets to enhance learners enjoyment. From this study, it could be concluded that computer-learning networks have the potential to empower students in well-designed learning environments. It is emphasized that the central computer-mediated learning experience in Language Studies can not be achieved by itself simply by the introduction of the learner to the web technology. Those learners who show reluctance towards technologically oriented projects need careful guidance and support from the pedagogical and technological applications of this self-directed curriculum. Therefore, providing scaffolding, both in using Internet applications and in orienting the learners to the task, is vital to the successful implementation and integration of technology into the curriculum.

It is undeniable that, being situated at the turn of 21 century as we are, developing the learner' s information literacy of the digital world is important. Learning to navigate and sift through huge amounts of information with speed and accuracy, as well as pursuing a critical level of understanding that goes well beyond literal or surface-level meaning, will prepare students for the challenges they will face as society delves deeper into the Information Age. The study calls for the learners' instrumental use of web technology to achieve language-specific goals. The project challenges learners to become both language and information literate in growing the following skills: awareness of global issues and concerns, the cross-cultural comparison, development of computer skills, enhancement of critical thinking and problem-solving skills, as well as specific communication skills such as arguing, persuading, or defending a particular point.

As the study shows, researching language instruction within a digital learning environment opens up a broader range of connections and meaning-making among learners. The present study is only a stepping stone on the way to examining learners' perceptions and attitudes toward the Web-based language project. Although this activity was conducted in a foreign language class, it could be adapted as an activity in a variety of disciplines to maximize the language dimension, such as social studies, global education, science, and cultural comparison [8]. The researcher believes that the possibilities for research in these powerful network environments will be conducive to broadening and refining language literacy.

References

[1] Bicknall, J., " Promoting writing and computer literacy skills through student-authored web Pages", TESOL Journal, Vol 8, No. 1, pp. 20-26, (1999).

[2] Green, A., "A beginner's guide to the internet in the foreign language classroom with a focus on the World Wide Web", Foreign Language Annals, Vol 30, No. 2, pp. 253-264, (1997).

[3] Garza, T., "The message is the medium: Using video materials to facilitate foreign language performance", Texas Papers in Foreign Language Education, Vol 2, No.2, pp.1-18, (1996)

[4] Lee, L., "Using internet tools as an enhancement of c2 teaching and learning", Foreign Language Annals, Vol 30, No. 3, pp. 410-27, (1997)

[5] Rankin, W., "Increasing the communicative competence of foreign language students through the FL chatroom", Foreign Language Annals, Vol 30, No. 4, pp. 542-546, (1997)

[6] Warschauer, M., "Computer-mediated collaborative learning", Modern Language Journal, Vol 81, No. 4, pp. 470-481, (1997)

[7] Ayersman, D., "Reviewing the research on hypermedia-based learning", Journal of Research on Computing in Education, Vol 28, No. 4, pp. 500-526, (1996)

[8] Moore, Z., " Technology and teaching culture in the L2 classroom: An introduction", Journal of Educational Computing Research, Vol 20, No., 1, pp. 1-9, (1999)

Construct in-service Training Web Site for School Teachers

Jia-Rong Jerome Wen* and Wen-Chin Chen**
**jerome@nknucc.nknu.edu.tw*
***timmy@icemail.nknu.edu.tw*

1 Introduction

Information technology grows rapidly recently. People use Internet to obtain many kinds of information. The Internet has become the most important path in cyber world. In the last five years, using the Internet to carry out distance learning, especially for teachers' in-service training, changes the style of education.

To actualize the policy which was to build an lifelong-learning education environment, Ministry of Education delegated National Kaohsiung Normal University (NKNU) to manage Asynchronous Distance Learning class for high school teachers in Oct, 1999.

2 Construct Asynchronous Distance Learning Web page

Generally speaking, teachers have to control the instructive materials, activities, learning process and evaluation. Every instruction system must include all of the three factors as following:

2.1 Instructive materials and activity designing

If we just put the materials onto web site, they look like electronic books on Internet. It is helpless for students. Therefore, when designing the contents of curriculum, we make it in "practicing" orientation. Activities make teacher and students interact with each other and avoid students to feel humdrum or like reading an electronic book.

2.2 Evaluation

When students finish learning a chapter, we give them an formative evaluation to verify whether students master the thesis or not. If students pass the formative evaluation, they can continue the curriculum. If not, they have to go back and learn it again until they pass the formative evaluation. The system would give some feedback to students, they would know which part of contents they don't understand yet. Then, we always hold an examination when finishing the curriculum, the summative evaluation. (Figure-1)

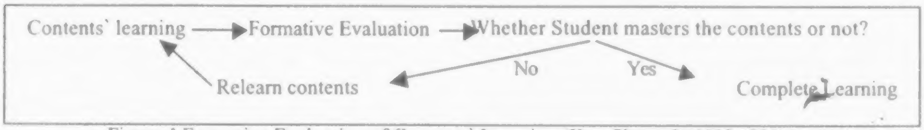


Figure-1 Formative Evaluation of Contents` Learning (Kuo Sheng-lu,1993,p294)

2.3 Learning process

Instead of quantification of examination, we should care about the reflection from students after instruction and learning. Grades cannot decide students` learning efficiency. During designing the materials, we considered every details of students` learning process. These include

- counts in connection
- counts in joining the forum
- contents what student discuss
- chatting situation between teacher and students

- Homework – students work hard or not
- Chapter evaluation (formative evaluation)
- teachers and students communicate by email

All items can be saved into database so that we can estimate student' s behavior in learning.

3 Concepts on designing curriculum

We design several activities and strategies. The activities will make students concentrate on the contents. we consider about the strategies as following:

3.1 Homework:

We assign homework after students finish learning every chapter. They can evaluate themselves through homework to know how much they learn and review contents again.

3.2 Operative Orientation:

In the homework, they have to work some operation by computer, such as computer game.

3.3 Self-determination:

Self-determination means that students have to study by themselves and plan study schedule by themselves.

3.4 Interactive :

We define interaction into two ways : one direction and two direction (Table-1).

	One direction	Two direction
Asynchronous	Announcement FAQ	On-Line Forum
Synchronous		Chat Room

One direction: teacher to student
Two direction: teacher and student

Table-1 Interactive model

3.5 User Interface• •

What users feel about it is very important in internet environment. Hyperlink always be mazes for a novice in the internet. Trying to solve user interface problem , we use several ways as following :

3.5.1 Frame• cut web pages into several frame to reduce confusing

3.5.2 Tree menu• from the reaction of students , the tree menu is easy to access the pages

3.5.3 Learning Path• guideline for students on the web

References

[1] Fred Jevons."Distance Education and Campus-Based Education : Parity of Esteem", New South Wales, Australia : Peter Smith and Mavis Kelly. (1987)

[2] Kuo Sheng-Iu(1993). "The Evaluation of Psychology and Education", Chin-Hua , 7th Edition., (1993).

[3] Lisa Neal(1998). "Distance Learning". ACM(http://www.acm.org)(accessed on May 15,2000).

[4] Mei-Sheng Chao, "The Impact of a Systems Approach on Interactive Distance Teaching: The Development of the ATM Video Network System at National Chung-cheng University", ETR&D, Vol 47. No 2. pp. 112-117(1998).

[5] Sun Chuen-tzai, Chu Ching-hao, & Shiu I-di, "The research of constructing hypermedia teaching material", Information and Education• vol. 67• pp 13-25(1998).

[6] Wang Chien-Shin, "Web-based network system for instructive management", Information and Education, Vol. 67• pp 3-12(1998)

[7] Wen Jia-rong, "The research on present Statement and Requirements of junior-high-school Information Education", Information and Education, Vol. 51, pp17-26(1996)

[8] Wen Jia-rong, Wu Ming-lung , "Information Education Theories and Applications in New Age ", Song Kang ,1st Edition.(1999).

[9] Han Shan-ming, "Information Education Fundamental Construction – Speed", Information and Education, Vol. 68, pp14-16 (1998)

Constructing a Real-Time CAD Learning System Based on OpenGL in Web-Based Environment

Wen-Chai Song*, Shih-Ching Ou*,Song-Rong Shiau**
**Department of Electrical Engineering, National Central University, Taiwan*
***Department of Electrical Engineering, National Taipei University of Technology, Taiwan*
4F,NO.184-1,Kee-Kin 1st Road,An Lo District, 204, Keelung ,Taiwan
Tel:+886-2-24325455
Fax:+886-2-24324075
E-mail:songchen@ms10.hinet.net

The purpose of this paper is to apply network technology to make the design of Web-based learning graphics systems for user. Several issues will be addressed in this paper such as the development of an Integrated Interactive Graphics System (IIGS) for a better design environment. In this paper, we attempted to develop a web-based graphics learning system by Bézier, B-spline and NURBS algorithms. The purpose of the research was to increase the effect of Computer-Aided Design (CAD) in network .The other advantages is that network browser is the common platform in internet and intranet, the graphics system can be portable cross different operating system, as like windows 98,linux..etc. In fact, the graphics learning system have attempted to be shared the resource each other.

Keyword: **OpenGL, VRML, NURBS, CAD/CAM, CAI, Curves, Surfaces**

1 Introduction

As the Internet has improved in the last ten years, web-based graphics learning has become very important in Internet. In recent year, the distance learning by Internet has been established and developed in Computer-Assisted Instruction (CAI) system. In this paper, the user can design and learning sculpture curves and surfaces on a personal computer by the interactive way. The graphics system has friendly interface in operating process.

OpenGL is a software interface that allows the programmer to create 2D and 3D graphics images. OpenGL are both a standard API and the implementation of API. In other words, OpenGL is a set of functions which have the same syntax and which act the same way on every platform, even though different vendors have written the actual subroutines, which implemented the API standard.

Graphics programming concepts underlie the function of OpenGL. These concepts are easy for the average application programmer to understand and use. OpenGL is independent of the hardware, operating, and windowing systems in use. Using OpenGL to make a program is easier than using API to do. API is integrated into a windowing system, since learning how to program a windowing system is often quite complicated.

2 Curve Modeling

Curve methods are usually included in different courses such as geometric modeling, CAD/CAM, computer-aided geometric design (CAGD), computer graphics, etc. In teaching this material, it is essential that students have an access to computer graphics facilities. Practical experiences help them to understand the dry theory. There are many books concerning curve and surface modeling and each of them considers this subject in a different way (with some modifications). Users are confused, especially beginners. The next weakness of method representations is in lack of comparative means. Learning can be more effective if different methods are studied simultaneously on the same data by changing control parameters.

This field is developing very quickly and therefore researchers need also an effective comparative tool for their new improved approaches or methods. For these reasons, a program package for modeling and analysis of parametric curve methods called CM ("Curves Modeling") has been constructed. It is written in OpenGL. Not only 2D but also 3D curves are considered. Three various methods are incorporated in CM in the first menu level. Including all menu levels, there are ten methods or their modifications. In the interpolation methods, a curve passes through all control points, in the approximation methods, however, a curve passes only near to control points.

Figure 1. The Curve modeling interface

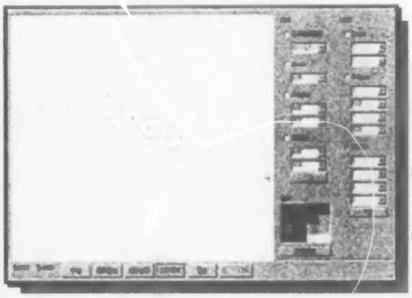


Figure 2. The Surface-modeling interface

A curve is compounded of small curves called curve segments and is determined by an equation in parametrical form (parameter u). In the knot vector for u (Uknot), there are parameter values for segment boundaries.

3 The Bézier, B-spline and NURBS Curves Algorithms.(extract)

NURBS curves:

A pth-degree NURBS curve is defined by

$$C(u)=\frac{\sum_{i=0}^{n}N_{i,p}(u)w_iP_i}{\sum_{i=0}^{n}N_{i,p}(u)w_i}\qquad a\leq u\leq b \tag{12}$$

Where the {Pi} are the control points (forming a control polygon), the {Wi} are the weights, and the {Ni,p(u)}are the pth-degree B-spline basis functions defined on the non-periodic (and non-uniform) knot vector.

$$U=\left\{\underbrace{a,\ldots,a}_{p+1},u_{p+1},\ldots,u_{m-p-1},\underbrace{b,\ldots,b}_{p+1}\right\} \tag{13}$$

4 Surfaces Modeling

In the computer graphics, a surface is usually generated by a surface representation method on a control net (linked control points in a 3D space). Methods for surface representation are divided in two major groups: approximation and interpolation methods. At the interpolation methods, a surface passes through all control points, at the approximation methods , however, a surface passes only near to control points. A surface is compounded of small surfaces, called patches, presented by two families of isoparametric curves.

A program package for modeling and analysis of parametric surface methods called SM ("Surfaces

Modeling") has been constructed .A surface is determined by an equation in parametrical form (parameters u and v). We speak about u and v directions (parametrical view) or about direction X and direction Y respectively (2D screen view). In the knot vectors for u and v (Uknot, Vknot), there are parameter values u and v for patch boundaries.

5 The Bézier, B-spline and NURBS Surfaces Algorithms.(extract)

NURBS surfaces:

A NURBS surface of degree p in the u direction and degree q in the v direction is a bivariate vector-valued piecewise rational function of the form

$$S(u,v)=\frac{\sum_{i=0}^{n}\sum_{j=0}^{m} N_{i,p}(u)N_{j,q}(v)w_{i,j}P_{i,j}}{\sum_{i=0}^{n}\sum_{j=0}^{m} N_{i,p}(u)N_{j,q}(v)w_{i,j}} \qquad 0 \le u,v \le 1 \tag{14}$$

The $\{P_{i,j}\}$ from a bi-directional control net ,the $\{W_{i,j}\}$ are the weights ,and the $\{N_{i,p}(u)\}$ and $\{N_{j,q}(v)\}$ are the non-rational B-spline basis functions defined on the knot vectors

6 The structure of the graphics learning system:

(1)System operating process and interface:

(2) Graphics algorithms:

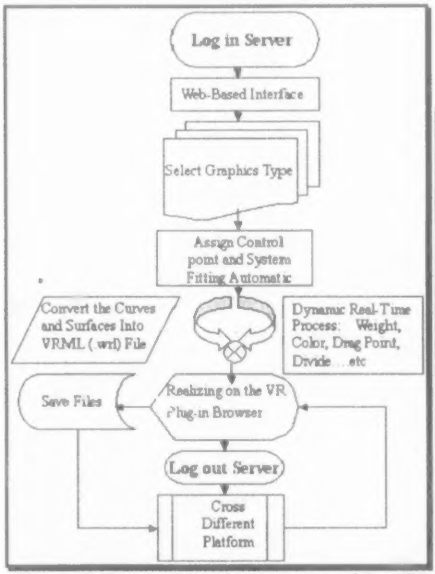

Log in Server
Web-Based Interface
Select Graphics Type
Assign Control point and System Fitting Automatic
Convert the Curves and Surfaces Into VRML (.wrl) File
Dynamic Real-Time Process: Weight, Color, Drag Point, Divide ... etc
Save Files
Realizing on the VR Plug-in Browser
Log out Server
Cross Different Platform

Figure 3. System operating process and interface.

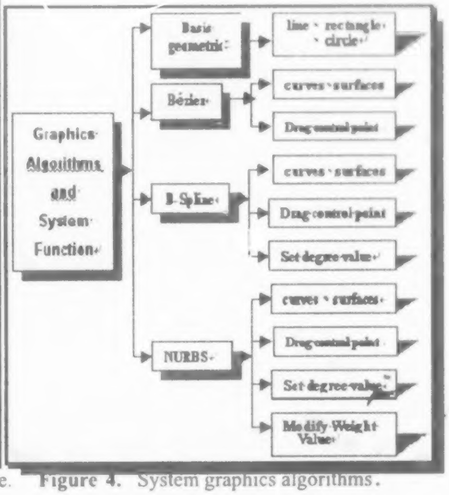

Graphics Algorithms and System Function
Basis geometric
line、rectangle、circle
Bézier
curves、surfaces
Drag control point
B-Spline
curves、surfaces
Drag control point
Set degree value
NURBS
curves、surfaces
Drag control point
Set degree value
Modify Weight Value

Figure 4. System graphics algorithms.

7 Brief Overview of OpenGL

OpenGL is the premier environment for developing portable, interactive 2D and 3D graphics applications. OpenGL have the following obvious benefits:

(1) Reliable and portable

(2) Scalable

BEST COPY AVAILABLE

(3) Easy to use

VR as a Training Tool

Virtual Reality training can dramatically reduce the cost of delivering training by decreasing learning time for student and instructors.

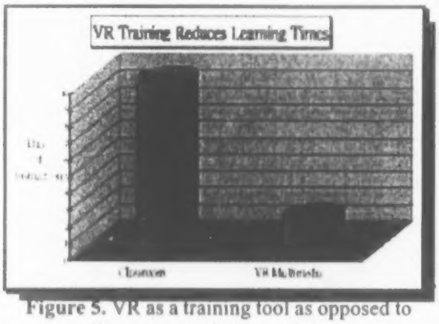


Figure 5. VR as a training tool as opposed to Classroom techniques (RTI)

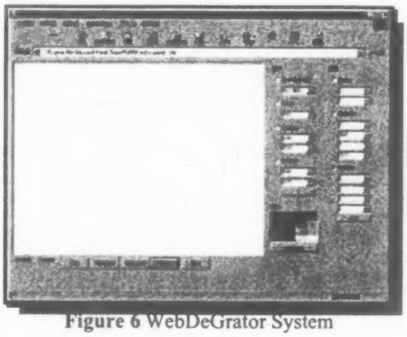


Figure 6 WebDeGrator System

8 Implementation and Example:

(1)The Integrated graphics Learning real-time system:
(2)Drawing NURBS curves and Covert Curves into VRML 3D Type:

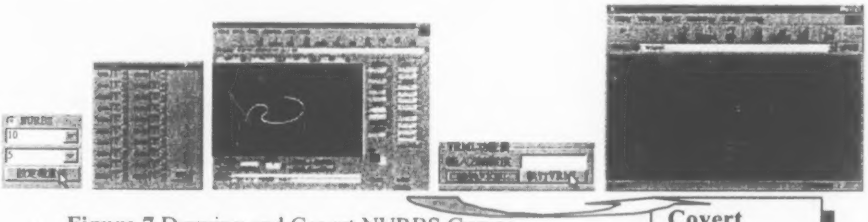


Figure 7 Drawing and Covert NURBS Curves

Covert VRML Type

9 Experiment results:

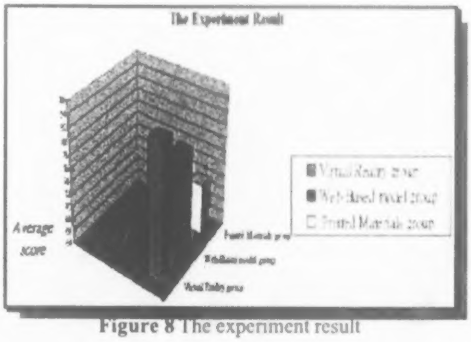


Figure 8 The experiment result

While the differences between the groups were significantly different, the virtual reality group performed is best; the Web-based model group is better than the printed materials group.

10 Conclusion:

The paper describes a new technology that we have established a VR-Based real-time graphics system. In summary, the system offers the following contributions:

1. To accomplish an Integrated Graphics Learning Real-time System
2. To share the resources in network.
3. To establish a computer network assisted learning system.
4. To explore and compare these algorithms of the sculpture curves and surfaces.
5. To integrate VRML with web-based learning system and realize 3D graphics on VR environment

11 Acknowledgments:

We would like to thank the anonymous reviewers for their invaluable and constructive comments that help to improve this paper. This research is working by the Automatic & CAD laboratory under Department of Electrical Engineering National Central University, Taiwan.

12 References:

[1] Ainge D. J., "Upper primary students constructing and exploring three dimensional shapes: a comparison of virtual reality with card nets", J. Educational Computing Research, 14(4), pp 45-369.1996.

[2] Br.cken, M. A, "Description of the Human Interface Technology Laboratoryi s Virtual Worlds". Technical Report, Human Interface Technology Laboratory, U. of Washington, Seattle: 1990

[3] Christine Youngblut.."Educational Uses of Virtual Reality Technology". Institute for Defense Analyses. 1998

[4] Clark, R.E. "Reconsidering Research on Learning from Media". Review of Educational Research, winter, Vol. 53, No. 4, pp. 445-459, 1983

[5] Flanagan, D.: "Java in Nutshell, A desktop quick reference - Java 1.1", Second edition, O'Reilly, 1997.

[6] GERALD, "NURBS from Projective Geometry to Practical Use". FARIN,1999.

[7] Les Piegl. & Wayne Tiller." The NURBS Book". .Springer, 1997

[8] Manetta and R. Blade in "Glossary of Virtual Reality Terminology" in the International Journal of Virtual, 1998

Design and Evaluation of Constructivist Web-based Instructional Systems

Yueh-Chun Shih* and Nian-Shing Chen**
Department of Information Management
National Sun Yat-Sen University
*stone@cc.nsysu.edu.tw
***nschen@cc.nsysu.edu.tw*

Recently, there are many web-based instructional systems that have been developed on the Internet. Most of them claim that their system designs are based on constructivism. However, how to really evaluate if a web-based instructional system is a constructivist system or not, we need a complete evaluation guidelines which are derived from learning theories of constructivism. In this study we proposed a set of guidelines for evaluation of constructivist web-based instructional systems by surveying literature articles and analyzing constructivism theory. We then evaluate several popular web-based instructional systems by applying the proposed guidelines. Hope the proposed guidelines have some helps to the design and upgrade of web-based instructional systems, and can be an evaluation guidelines for constructivist web-based instructional systems.

Keywords: **Constructivism, Web-based Instructional System, Distance Education, Cyber University**

1 Introduction

From the 1990, Internet was booming globally in a tremendous speed. The population of people using Internet in the world is growing quickly in an exponential rate. Just like another industrial revolution, Internet has decisively deep and far impacts on our life. Currently the web-based instruction, using new media on the Internet, has the most conspicuous impacts on distance education as well as on traditional instruction type. Lines between these two kinds of instructional methods begin to be blurred [11]. Nowadays, many colleges and universities also begin to put the distance education into practice through Internet, hoping to enhance the learning efficiency by conducting new educational methodologies from Internet media. The asynchronous distance education, enabling teachers and students to interactively share information, to teach, to learn and to discuss anytime by connecting to the web-based instructional system, is one of the examples taking advantage of the computer software and Internet tools to simulate circumstances of giving lessons in the classroom. This leads us to another new kind of instructional schemes. At present researches in the light of this instructional system are continuously going on [12].

According to the architecture of many web-based instructional systems discussed [8,9,10] and the experience of developing this kind of system [3,5,6,7], we found that most of the systems developed were some sorts of system integration based on technical layers, and designers of these systems all thought the features of these systems could realize the circumstances of constructivist instruction. But whether the learning theories of constructivism can be fully achieved or not by the web-based instructional system is still a question which makes system designers and people with intention to establish the system indecisive and needs more guidelines for evaluation.

The objective of this research is trying to propose guidelines for evaluation of web-based instructional systems, hoping to be able to help with system development and become guidelines for evaluation. Besides these guidelines built in this research, case studies of comparison and evaluation on some famous web-based instructional systems will also be conducted.

2 Guidelines for constructivist instructional system design

Yi [13] definitely pointed out five principles for system design in his experimental schema:

(1) The ability to provide a process for knowledge construction.
(2) The ability to provide a circumstance relative to actual real actions for learning.
(3) The ability to provide an experience for viewing the points from each aspect.
(4) The ability to provide an environment to experience the social learning process.
(5) The ability to provide presenting methods for media.

But some of these guidelines nowadays have been essential and existing functions due to the advancement of technology. The ability, which the system has to be equipped with, of providing learning circumstance related to real activities, for example, could be achieved by the multimedia on WWW since it could present information in different types such as text, charts, pictures, video, images and language. And users can select appropriate media for presenting instructional materials so that a realistic circumstance could be simulated with interactive lessons and useful information could be embedded inside. As a result, taking the present technology into account, design of multimedia instructional circumstances can' t be classified as the problem of system functions but as the guidelines that require considering.

Furthermore, synchronous (such as videoconference including shared white boards and on-line chat) and asynchronous (such as e-mail and BBS) communication systems also can provide circumstances for social learning experience as well as experience in different observation viewpoints. Students can benefit from the information revealed by the system to learn from other's learning experiences. Therefore, we conclude the above mentioned two points as that the system should provide circumstances capable of forming learning groups.

Thus, the original five guidelines for system design proposed by Yi [13] could be modified as below:

Guideline 1 Capable of providing processes for knowledge construction.

Users can decide the methods of their own to explore the information they need, such as selecting learning contents, determining learning sequences and participating in learning processes actively. Besides, as to the specific problems assigned by teachers, they also can explore the information provided by the system and then add their opinions into their knowledge base according to the information they have collected. They can record the processes of knowledge construction by system functions as well.

Guideline 2 Capable of providing circumstances for forming learning groups.

The system should provide functions for students to interact with each other and social experiences for learning reference. Students can make self-examination on his thoughts by observing the viewpoints of others. The information revealed by the system would determine how users learn.

In response to the requirements for the information society of next age, demands for students' ability should become omnidirecion-oriented. Besides simply knowledge gaining, abilities of high-level thinking, knowledge integration, creation and problem solving as well as human relationship are all required. For this reason, in addition to these two guidelines mentioned above, we propose another five guidelines from the point of constructivism literatures and social requirements.

Guideline 3 Capable of providing an environment for easy use.

The patterns of interactions in class can be defined as between students and teachers, between students and teaching materials, and between learners.

Guideline 4 Capable of providing an environment for dynamically exploring information

Chang [1] indicates that the knowledge will be constructed through dynamically exploring and discovery.

Guideline 5 Capable of providing an environment for observing the operation of other users.

From the point of the learning theory of constructivist psychology, through the cooperative learning of discussing, observing and consulting, it's easier to achieve self-thinking and constructivist learning.

Guideline 6 Capable of providing a cooperative learning environment for groups.

The system should provide an environment for member discussing, team forming and lessons learning with the assistance of Internet. That can lead to the achievement of the requirements which the information society of next age needs, and also fulfill the third principle of modern constructivism.

Guideline 7 Capable of providing an environment for recording the learning process.

The system should automatically record the performance, check the sequence and time of teaching materials, and trace the activity of problem solving and information seeking.

Through the literature review, we conclude the seven principles mentioned above. They should be conducive to the design of new systems and the update of old systems to assist teachers and students in constructivist instructional activities. We will use these principles to evaluate some instructional systems.

3 Evaluation of foreign web-based instructional system

Listed here are some popular web-based instructional systems being evaluated by Chen & Shih [2] with their function analysis. We will use the designing guidelines of constructivist instructional system described above to evaluate these systems again.

- WebCT web-based instructional system (http://www.webct.com)

  WebCT (version 2.0) was a kind of web-based instructional system developed by Department of Computer Science at the University of British Columbia. Table 1 is an evaluation table resulting from the analysis with the guidelines (based on the functions listed in the WebCT White Paper, August 1999). From table 1, we find that the system conforms to some guidelines and provides better function for knowledge construction process and ease of use. But it is deficient in-group learning, which needs further enhancement of related features.

- Learning Space web-based instructional system (http://www.lotus.com/learningspace)

  LearningSpace (LearningSpace Anytime 3.0) was a web-based instructional system developed by IBM. Table 1 is an evaluation table resulting from the analysis with the guidelines (based on the functions listed in the LearningSpace anytime 3.0, June 1999). We find in table 1 that it provides better function for forming learning groups but is deficient in other components such as knowledge construction, records of learning process, and group learning environment.

- Hyperwave web-based instructional system (http://www.hyperwave.com/)

  Hyperwave (Version 5.0) was a system developed by a private corporation in German to build an Internet system. Table 1 is an evaluation table resulting from the analysis with the guidelines (based on the functions listed in the Hyperwave Information Server 5.0 Technology White Paper Version 1.2 6/18/1999). From table 1, we find that it isn't really a constructivist web-based instructional system. More functions should be added.

- TopClass web-based instructional system (http://www.wbtsystems.com/)

  TopClass is web-based training software developed by a private corporation WBT Systems in California, USA. Table 1 is an evaluation table resulting from the analysis with the guidelines (based on the functions listed in the WBT's White Papers, September 1998). From table 1, we find the system has its strength on the ability of learning process recording. Enhancement of the functions on other parts such as knowledge construction, provision of multimedia and group learning should be made.

- The Cyber University of NSYSU (http://cu.nsysu.edu.tw/)

  The Cyber University of NSYSU is a web-based instructional system developed by NSYSU. From the table 5, we know that each function of the system meets the guidelines, especially in the aspects of providing environments for group learning and forming group society.

Table 1. Evaluation of the web-based instructional systems

Guideline	WebCT	LearningSpace	Hyperwave	TopClass	NSYSU
1	✓	×	⊗	×	✓
2	⊗	✓	×	⊗	✓
3	✓	⊗	⊗	⊗	✓
4	⊗	⊗	⊗	⊗	✓
5	×	×	×	×	✓
6	×	✓	⊗	×	✓
7	✓	×	⊗	✓	✓

✓• provided ×• not provided ⊗• partly provided

4 Conclusion

The booming of Internet creates a brand new learning environment. It is also recognized to be the most suitable tools for developing constructivist instructional circumstances. But since a good web-based instructional system plays an important role in developing web-based instructional environment, this research analyzed and summarized a set of guidelines for designing constructivist instructional system after reviewing literatures related to constructivism learning theory. With the guidelines proposed here, we evaluated and compared with some famous web-based instructional systems.

Meanwhile, we found some existing problems and issues worthy of further research. At the evaluation report by Chen & Shih [4], the ranking of these five instructional systems is LearningSpace, The Cyber University of NSYSU, TopClass, WebCT, and Hyperwave. But our evaluation report shows that from the viewpoint of requirements of constructivist education, there is no system but the Cyber University of NSYSU that satisfies the guidelines proposed. In the past, the LearningSpace developed by IBM once owned most complete functions and best reputation. But under the examine principles, it only conformed to part of these guidelines. It reveals that systems in the past were mostly technology-focused but lack of the understanding that the system should meet the nature, the objective, and the theory of the education.

Since the instruction is an extension of learning, designing of instructional activities should conform to the learning theory. We believe that future research should not only pay attention to the technology of the web-based instructional systems but also be designed in accordance with the learning theory without disregarding the nature and the original objective of education. We hope that guidelines proposed in this research could be of great help in designing new systems and upgrading old ones and moreover provide the system design with a clear and definite objective and direction.

Acknowledgement

The Study is supported by the Program for Promoting Academic Excellence of Universities by Ministry of Education of R.O.C..

References

[1] Chang, Shih-Ju, "The Instructional Meaning of Hypertext and Hypermedia: from Constructivism point of view.", Information and Education, No. 58, pp.39-48, (1997).

[2] Chen, N. S. & Shih, Y.C., "The Conceptual Model of Web-Based Instruction System and Its Implementation.", In Cumming G., Okamoto T., & L. Gometz (Eds.), "Advanced research in computers and communications in education: New human abilities for the networked society" (Vol. II, pp. 780-783). Amsterdam: IOS Press, (1999).

[3] Chen, N. S., "Webtitle- education on line", http://www.nsysu.edu.tw/webtitle.html (accessed on July 1, 1997).

[4] Chen, N.S. and Shih Y.C., "Function Analysis and System Implementation for Web-based Instruction System", The 13th Seminar of Computer Aid Instruction, the R.O.C., pp. 81-104, (1999).

[5] Chen, N.S. and Wang Min-Huang, "Web-based Supplementary Tool and Courseware", The Eighth Thesis of International Seminar on Information Management, pp.667-674, (1997).

[6] Chen, N.S., "Web-Based Learning Environment", Information and Education, No. 64, pp. 2-13, (1998).

[7] Chen, N.S., Yang Tsu-Ching, and Lai Hang-Jen, "Learning Environment based on Internet", Journal of Computers, Issue II, pp. 667-674, (1997).

[8] Goldberg, W. M., "Using a web-based course authoring tool to develop sophisticated web-based courses", Educational Technologies Press, July, (1996a) .

[9] Goldberg, W. M., "Student participation and progress tracking for web-based courses using webct.", Proceedings of the Second International N.A. , WEB Conference, October 5-8, Fredericton, NB, Canada, (1996b).

[10] Goldberg, W. M., "Communication and collaboration tools in webct.", Proceedings of the conference Enabling Network-Based Learning, May, 28-30, Espoo, Finland, (1997).

[11] Lee, Chin-Pao, Han, Hui-Wen, Tsou, Ching-Ping, Hung, Shih-Chia, Chuang, ShuMi, "The trend and Current State of Information-net Training", Distance Education,Vol. 6, pp. 30-37, (1998).

[12] Okawa, K. & Murai , J., "School of the Internet : a university on the internet", http://power2.nsysu.edu.tw/INET98/7b/7b_2.htm, (accessed on July 1, 1998).

[13] Yi, Lien Hui, "Study of Computer Assisted constructivist Learning", Master Thesis of National Taiwan Normal University, (1993).

Design and Implementation of Teaching Models in Web-Based Teacher Training

See-Min Kim*, Shin-Chon Kang, Young-Kyun Back****
** CRADLE, Tokyo Institute of Technology*
2-12-1, Ookayama, Meguro-ku, Tokyo, Japan 152-8552
Tel: +81-3-5734-3233, Fax: +81-3-5734-2995,
E-mail: kim@ak.cradle.titech.ac.jp
*** Korea National Universty of Education*
Darak-ri, Kangne-myon, Chongwon-kun, Chugbuk, Korea 363-791
Tel: +82-431-230-3431, Fax: +82-431-233-0664,
E-mail: skytop@chollian.net

The reform of teacher training started in May 1995 in the Republic of Korea with reform of the educational system. The core of the reform was reinforcement of teacher training activity and introduction of a DTTS(Distance Teacher Training System). Then, in order to introduce a DTTS, the project for distance teacher training model development started in September 1997. This paper is related to a design and implementation of a teacher model in a DTTS. The teaching models of the following 4 types were carried out. 1) Problem-Solving type, 2) Seminar type, 3) Lecture-Practice type, 4) Courseware type. This system was in operation from October 1998. Current problems of this teacher models include: 1) Poorness of course contents, 2) The difficulty of checking a learning process, 3) Insufficiency of feedback to a trainee etc.

Keywords: **Distance Teacher Training, Teacher Model, Web-Based Learning**

1 Introduction

In Korea, reform of teacher training started on May 31, 1995 with the announcement of a reform of the educational system proposal. Philosophical bases for reform of teacher training are the spirit of the opened education, enshrining the principles of, opened an educational opportunity, the learning speed, the contents of learning, and the learning method, etc. The contents of reform are as follows[5]:

1) Obligation of periodical training;
2) Execution of distance education that introduced high technology of information communication engineering;
3) Reflection to the personnel affairs and the salary of a training result;
4) Authorization of a special course completion result in a graduate school and a social-education organization;
5) Attempt to the improvement of the training organization that enabled selection of the training organization by the teacher and let competition pass in qualitative.

These are summarized the following: 1) reinforcement of teacher training activity 2) introduction of a DTTS(distance teacher training system). It aimed at an expansion of the training opportunity, and overcoming restriction of time and space, with a reduction of training expenses. The project of DTTS development started in September 1997. It was sponsored by the Korea Multimedia Education Center. This project was divided into 4 sub-projects: Develop a training support model, design for teaching model, courseware development, and development for system management model. This paper is related to a design and implementation of a teacher model in a DTTS.

A teacher model is dependent on the contents of course, the learner characteristic, learning environment, etc. [6]. According to the questionnaire for the teachers and educational professionals of Choi [2], the suitable course for distance teacher training is as follows.

1) Various culture subjects (humanities a subject and a theoretical field).
2) Teaching methods expected such as discussion and workshop, then a lecture.

In Korea, as a training course into the distance teacher training, the culture subject of 11 was chosen. These were, "Foreknowledge of the future society and a counter plan", "Understanding of traditional culture", "The world in the 21st century and the Korea", "An information society and a computer", "Environment and education", " Raising of national morality nature", "An information society and multimedia education", "Theory and practice of open education", "The direction of the educational system reform and school reform", "Education of humanity and originality", "Education for a unification counter plan".

In consideration of the characteristic of subjects and learner, strategies of WBI(Web-Based Instruction)[1], the teaching model of the following four types was proposed. 1) Problem-solving type, 2) Seminar type, 3) Lecture-practice type, 4) Courseware type. These are described at length in sections 2-4.

2 Design of the Teaching Model

In this project, the model of distance teacher training was divided into the macro model and the micro model, and was developed accordingly. A macro model is the framework of the whole DTTS, and a micro model is the course of training, that is, a teaching model. A macro model and a micro model are unified and distance teacher training is managed.

2.1 Web-Based Instructional Strategies

The acquisition process of the knowledge in WBI and the approach of the learning of constructivism are very similar. The most basic principles of constructivism concern fundamental philosophical assumptions about knowledge and learning[4]. The first, more generally accepted principle is that what a person "know"is not passively received, but actively assembled by the learner. The second principle is that learning serves an adaptive function. That is, learning is not the storage of "truths,"but of useful personal knowledge. This means the importance of the context of learning. Context has a lot to do with what is perceived as useful knowledge and how what is learned is integrated with existing knowledge. And the assumption that education is about acquiring universal truths. Since each person has different experiences and constructs an individual account of these experiences, each persons' s reality is slightly differenbt. New expereriences are interpreted within the context of these individual realities, implying that each person "know"a particular thing in a slightly different way.

We introduced the application of a repertoire of cognitively oriented instructional strategies implemented within a constructivist and collaborative learning environment, utilizing the attributes and resources of the internet[1]. The instructional strategies may be designed the following ways:

1) Support to the interaction between a lecturer- learner, and a learner-learner.
2) Introduce a hyper-textual function and support individualization learning.
3) Various learning materials provide in real time or non-real time (multimedia support)
4) The contents of learned and an evaluation results are analyzed rapidly and correctly, and it offers feedback to learner and system side.
5) Provide of DB Retrieval Function for learning information
6) It cooperates with other educational networks, and mutual reference can be carried out.

2.2 The contents-characteristic of subjects

The courses designed by the DTTS were culture subjects of 11. Generally, the contents of culture subject in a training course are unlike 'learning subject' that gains new knowledge. The culture subjects are mainly implicated that the contents of knowledge or skill newly asked for with a social change. And it takes into consideration that learning environment is being home, designed so that it might participate in learning not passive position but positively.

1) Show many concrete examples so that positive and concrete study can be performed.
2) Show or introduce the newest data and the newest present condition. And a learner performs creation of a report, discussion, and practice based on this.
3) In order to check rationally learning process which is the blind spot of home study, a small-scale subjectivity formula or report is required of an evaluation item.

4) The teaching contents are selected based on an opinion of the highest specialist of the field.

2.3 The learner-characteristic of in-service teacher and consult the needs analysis

In designing we considered the needs analysis of teacher needs[2]. And also considered the spirit of teacher training reform, that is the open educational opportunity, the learning speed, the learning contents, and the learning method, etc.

3 Proposed Teaching Models

3.1 Problem-Solving type Model

This model is used the following three subjects with "understanding of tradition culture", "information society and a computer "and "environment and education". The characteristics of contents of these subjects have much problem socially now. For example, the latest children cannot have understand about traditional culture, and do not understand value either. Moreover, although environmental problems are scattered in the familiar place, the problem consciousness does not exist. It is the learning which considers how it is efficiently introduced, how solving these problems at an educational field.

Problem-Solving type model is shown in **Figure 3.1**.

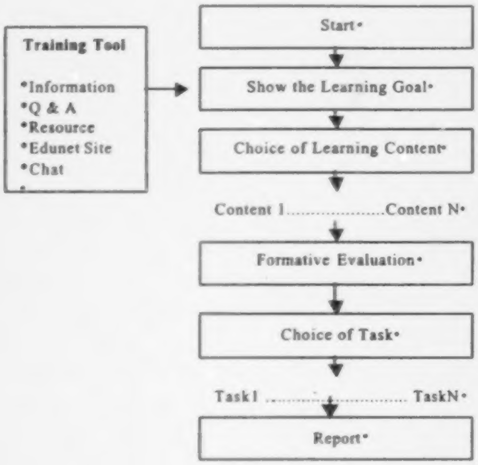


Figure 3.1 Problem-Solving type Model

3.2 Lecture-Practice type Model

Two subjects, "An information society and multimedia education" and "Theory and practice of open education" used this model. It is designed so that it might practice how theoretical knowledge may be reflected in the actual educational field. Through these courses, teacher can to help a child learn the capability that it can count measure to an information society, and how a teacher should just utilize the concept and the technology of multimedia for lesson activity. And more recently, it often pleads the open education. While introducing the concept of the open education and the example of the practice, teacher also gives an opportunity to consider an educational-practical use proposal directly.

3.3 Courseware type Model

Since three subjects, "Foreknowledge of the future society and a counter plan", "The world in the 21st century and the Korea", " Raising of national morality nature" were the contents of the type learned as new knowledge.

After having chosen the learning unit from the table of the learning contents, and learning using various data, composition which finishes a course through formation evaluation and generalization evaluation was designed.

3.4 Seminar type Model

This model uses the following three subjects. That is "The direction of the educational system reform and school reform", "Education of humanity and originality", "Education of a unification counter plan". At first a group is constructed by the theme and to be performed learning in Seminar form so that learner might have an opportunity to expand the view and develop the main point by the mode of opinion exchange.

Seminar type model is shown in **Figure 3.2** below.

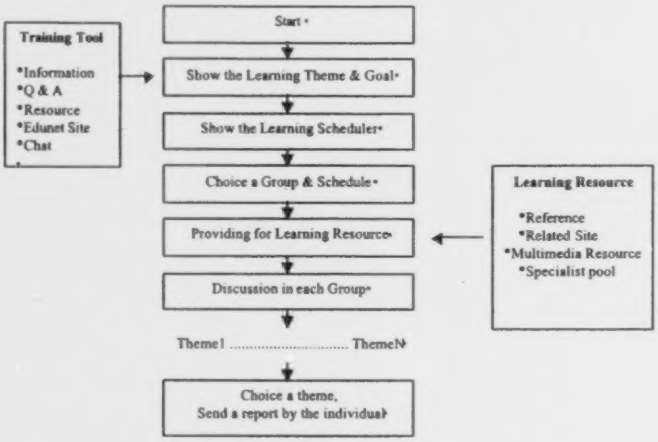

Training Tool
•Information
•Q & A
•Resource
•Edunet Site
•Chat
Start
Show the Learning Theme & Goal
Show the Learning Scheduler
Choice a Group & Schedule
Providing for Learning Resource
Discussion in each Group
Theme1 .... ThemeN
Choice a theme,
Send a report by the individual
Learning Resource
•Reference
•Related Site
•Multimedia Resource
•Specialist pool

Figure 3.2 Seminar type Model

4 Implementation

The proposed model went into test implementation from October 1998. And now the model is used for qualification study of elementary and the 1st class positive teacher of middle, and general training of an elementary deputy schoolmaster.

As problems of this teaching model the following may be mentioned: 1) Poorness of course contents, 2) The impossibility of checking a learning process, 3) The insufficiency of feedback to a learner etc.

5 Conclusions

The distance education which used the high technology of information communication engineering in Korea started in 1997[3]. Insufficiency of a lecturer and restriction of a training opportunity are well said as a problem in teacher trainings. As one proposal for solving this problem, the project of "Development of a distance teacher training system" started and virtual teacher training actually started from October 1998. Thereby, little by little, teacher training environment becomes better and we think that the opportunity of training and the improvement in qualitative teacher training may also be anticipated.

There are problems that should still be correct and complement continuously in this training system. But the problems that should solved urgently are preparing the method of evaluation, the monitor staff who helps training, and a specialist pool.

References

[1] Bijan B. Gillani & Anju Relan., "Incorporationg Interactivity and Multimedia into Web Based Instruction", Web-based instruction, Badrul H. Khan, (Eds.), Educational Technology Publications, Inc,. pp. 231-237, (1997).

[2] Choi, Sang-gun., "Development of Distance Teacher Training System", Seoul: Korea Education Research Institute, (1995).

[3] C. H. Lee., "Pre-service & In-service Teacher Training for Computer Education in Korea," Advanced Research in Computer and Communications in Education. G. Cumming et al.(Eds.), IOS Press, pp. 433-440, (1999).

[4] Mark Grabe & Cindy Grabe., "Integrating Technology for Meaningful Learning", Houghton Mifflin Company, pp.32-76, (1998)

[5] Pang, Myung-suk., "Teacher' s Information Literacy Training in the republic of Korea", Seoul; Korea Multimedia Education Center, (1998).

[6] Willis, B., "Instructional development for distance education," (ERIC Document Reproduction Service NO. ED 351 007), (1992).

DESIGN AND IMPLEMENTATION OF WEB-BASED LEARNING SYSTEM FOR TEACHER-TRAINING PROGRAMME

YIP Wai-ming* and AU Wing Kee**
**The Hong Kong Institute of Education*
10 Lo Ping Road, Tai Po, N.T. HONG KONG
Tel: +852 29487709
Fax: +852 29487726
E-mail: wmyip@ied.edu.hk
***The Hong Kong Institute of Education*
10 Lo Ping Road, Tai Po, N.T. HONG KONG
Tel: +852 29487693
Fax: +852 29487726
E-mail: wkau@ied.edu.hk

The advancement of recent technologies has evoked great impact on education. The Information Technology (IT) revolution has changed the habits of human civilizations immensely. The application of distributed systems, Internet, telecommunications and so on, along with the rapid development and advancement of computer technology, has given profound change to our life style and significant impact to our philosophy of education. Various contemporary issues in the application of IT in education have aroused widespread concern. Nowadays, learning is not necessarily confined within spatial and temporal boundaries. Networked databases, online resources and Internet services provide new opportunities for teachers and students to be engaged in learning and teaching activities which are different from the traditional classroom setting. In this paper, we are going to discuss the initial phase in designing and implementing a Web-based learning system for use in teacher-training programme. The research in building a Web-based supportive learning system for teacher training has the following characteristics: (1) It is a support system that aims to help the enhancement of learning effectiveness with the aids of modern information technologies, particular in the area of course information dissemination, sharing of resources, and computer mediated communication. (2) Future teachers are immersed in the IT learning environment so that a positive attitude and perception can be formed towards the adoption of IT in classroom. (3) Student teachers are encouraged to participate actively in the IT-immersion environment. After the initial phase completed, extended future research will be focus on its effectiveness and its empirical contribution in enhancing learning effectiveness.

Keywords: **Web-based Instruction**

1 Introduction

The application of Information Technology (IT) in education has recently generated lots of interests. With the advancement of new technologies, something impossible in the past was found significantly advantageous nowadays. One distinct example would be the use of digital technology and the continuous improvement of computer networks. The integration of text, sounds, graphics, and even video segments has been found more and more efficiently be used than in the past [9]. Undoubtedly, the fast growing multimedia technologies play a vital role in enhancing better learning and teaching effectiveness. Internet and the use of the World Wide Web (WWW) have been regarded as a powerful media since its development began in early 90's. Networked database and distributed systems make the "knowledge" and information dissemination more efficient and faster. As the Internet and the WWW remove the geographically boundaries, learning and teaching activities need not happen at the same time and at the same place. Furthermore, communications between teachers and students, and among the students, which traditionally relied on face-to-face interactions, can be supplemented by both synchronous and asynchronous modes of communication through recent development of telecommunication and network technologies. In order to meet the new learning needs in the new millenium the idea of learning network is established for promoting life-long learning. With the help of an immersion learning environment using IT, students can construct and refine their knowledge through interactions with other students and teachers at anytime and anywhere. In fact, the number of schools and Universities using the Web to deliver courses are increasing [6].

2 Rationale in using Web-based learning system for teacher training programme.

Khan [5] suggests that the Internet is fast emerging and the WWW is becoming an increasingly powerful, global, interactive, and dynamic medium for delivering instruction. More and more institutions are using the Web to provide instruction and training. Increasing number of these institutions offering Web-based courses are recognizing the fact the Web is a viable and important medium for learning and instruction. As the capabilities of the Web have become more widely known, students and faculty have been quick to utilize its potential [4]. Research on the use of Web-based system in the past decade often focused on its contribution to distance learning, flexible learning or open learning. Each of the above three terms has its own meaning and are different from each other, yet all of them are regarding learning happened at learners' own time, pace and schedule. Internet offers the potential for a classroom reconfiguration through the utilization of WWW as a tool. Teachers are no longer regarded as absolute authority and the fount of knowledge, but the students begin to take responsibility for their individual learning. They become active participants in acquisition of knowledge and need to be responsible for their own development. However, traditional learning system and Web-based system are not necessarily mutually exclusive of each other. On the contrary, they may be employed to support each other. This idea becomes the fundamental principle in establishing a flexible, learner-centred and effective Web-based supportive environment for learning.

To establish an IT-immersion environment for future teacher

Most of the universities in Australia, U.S. and U.K. require their graduates to be information literate. Education faculties within these universities would add stipulations that their pre-service teacher graduates would need to be competent with the application of IT in education.[1]. Another major reason in the development and implementation of Web-based learning system is to create an IT immersion environment, so that future teachers can be immersed in the situation that not only IT skills or literacy be taught, but provide opportunities for student teachers to build up confidence in using IT. As a result, their positive attitude and perception towards the application IT in the classroom can be developed. How IT is used will vary depending on teacher' s understanding of technology and how it may be used to support the learning and teaching process. The development of student teachers' positive, confident attitudes, self-efficacy, and perceptions toward Information Technology is essential. Bandura [2] stated that people who perform poorly might do so because they lack the skills or they have the skills but they lack the sense of efficacy to use them well. General self-efficacy beliefs reflect a sense of personal control, a sense of personal competence and goal-directed determination. The teacher' s beliefs in their personal efficacy, ability to motivate and promote student learning will affect the types of learning environments they create and the level of academic progress their students will achieve.

Practise what we preach

Student teachers need to be IT competent before they enter into the profession. Teacher educators also have a distinct role in preparing competent teachers to teach IT or can teach with IT in the classroom. It would be desirable to enable student teachers immersed in the IT learning environment so that they can experience the possibilities in using networked technology and telecommunication as one of the learning media. More importantly, they are provided a chance to venture out and form the habit of life long learning, which is an essential element in their future success. In view of learning strategies, throughout the use of new communication tools, students also have chances to collaborative with other students, and most likely they will be benefit from this kind of learning and teaching activities [7].

Flexibility, learner-centred approach

It is generally agreed that the Internet has the potential to revolutionize learning. However Radford [8] pointed out that a flexible and location-independent education is certainly not a replacement for traditional human face-to-face interaction between teachers and students, but on the contrary, provides another means to facilitate better communication. He said not all learning activities should be technology mediated, but in some way some learning tasks may not require people to be in the same room and at the same time. Lai [6] said that many "Web-assisted" courses are designed with the intention to provide students with easier access to course-related materials. Lecture notes, examination scripts and other relevant materials are archived on course Web sites and allow flexible access by course participants. In addition, electronic mail and discussion lists are used to supplement face-to-face communication between students and teachers. In some cases, they are only needed to meet face-to-face once or twice in a course.

3 System design

A pilot scheme has been introduced to explore the possibilities in using Web-based learning system in the Hong Kong Institute of Education since September 1999. The main purpose of this project is to look for the best means to support learning and teaching, and in the long run, develop courses that can be offered to the students in a flexible manner. A number of essential design principles in designing a Web-based learning system can be identified:

- Interactivity: Major considerations to enhance interaction between the learners as well as the teacher, a wide range of synchronous or asynchronous tools are used to supplement and/or enhance face-to-face interactions.
- Collaboration, it is important to establish a supportive environment to encourage collaboration or forming online study groups.
- Social and interpersonal interaction: the cognitive dimension of learning environment, to build up a best environment for learning, and to promote social and interpersonal interaction.
- User control: it should be designed for students and teachers easy to manipulate and most importantly, sense of ownership by providing personal space such as virtual office.
- Structure and management of learning environment, a Web-based learning environment should be a flexible learning environment includes clear and explicit information and simple administrative task.

The pilot system design consists of three components and each one serves different purposes in supporting learning.

Instructional delivery system

The main function is for information dissemination where instructional materials, announcement, lecture notes, tutorials etc. can be delivered via the Web and the learners may access the information at any time at their own pace.

Database

For the purpose of resource sharing, it serves information exchange, link resources, web resources, shared project examples and a platform for collection of assignments and feedback etc.

Internet-mediated Communication

The communication channel between the teachers and the students forms an important part in the Web-based learning system. It aims to provide a platform for Internet-based communication. Although email is a "conventional" way extensively used, other software tools for discussion and collaboration among students are employed. For example, newsgroup, guest book and discussion forumare adopted. Instructors may create a general discussion forum or specific topics to be debated that makes the learning activities more fruitful through student-teacher interaction.

4 Phases of development

This project comprises four phases.

Development and planning

The initial phase focussed on hardware infrastructure, setting up of software configuration, network connection, traffic and loading testing, security control method such as user authorization etc., Existing Web-based learning system were also installed, tested, compared and evaluated, examples included Learning Space, WebCT, Blackboard, etc.

Designing and testing

Course content design and the adoption of appropriate instructional delivery approach are crucial elements to the success of Web-based learning system. In this phase, different subject specialists in the Department of Information and Applied technology were invited to participate in the content design. Subjects included Information Technology, Home Economics, Business Studies and Design & Technology. Overall testing was also carried out in this phase including log on procedures, security control, database maintenance, statistics, Web-survey and evaluation etc.

Implementation

The system is opened for use but limited to specific courses level, which have been developed at the design phase. Formative evaluation will also be carried out to record

- feedback from both teachers and students.
- System stability
- Continuous modification and improvement on the content courseware design

Evaluation

As the Web can be globally been assessed, the use of formative evaluation is very critical where a single error will distribute world widely. An empirical approach will be adopted aims to observe effects on students and teachers using both quantitative and qualitative methods. This is an on-going process from the beginning till the end of the project. A variety of instruments will be employed, some important areas to be concerned are:

- Background study - Students and Teachers perceptions towards web-base learning
- Structure and in-depth interview – to obtain opinions from user point of view on web-based learning
- System analysis – a formative evaluation on the whole system concerning
    - the learning effectiveness
    - effective instructional design strategy
    - effectiveness on computer-mediated communication

5 Conclusion and future research

Information Technology develops at a rapid rate. The advancement of technologies provides new opportunities that never be achieved in the past. In particular the integration of multimedia technology and a new mode of communication using network technology that are greatly differ from our tradition. Brown (1999) states that there will be no doubt that the Internet is a major force in reshaping the nature of school. As the nature of Web-based system is open and flexible, the Web technology still has lots of potentials that can be contributed to education, especially in course design and development. On the other hand, the application of Web-based learning systems are continually to grow, it suggests future directions for educator and researcher to investigate how this new learning technology can contribute to along with educational and learning theories.

The initial phase of this project is to build up a platform for web-based learning systems. Extended future research will mainly focus on evaluation of such systems in enhancing teaching and learning effectiveness and its contribution to instructional strategy.

Reference

[1] Au, W.K., Kong, S.C. Leung, K.P. Ng, M. W. E., Pun, S.W.. "Levels of Information Technology (IT) competency core course elements and assessment tools for teacher training in IT in education". Hong Kong: Hong Kong Government. (1999).

[2] Bandura, A."Perceived Self – efficacy in cognitive development and functioning", Educational Psychologist vol 28 No.2 pp 117-148 (1993).

[3] Brown M.E. "The wired curriculum, a choice of content, connectivity or community?" In Lai, K.W. (Ed.) Networking, teaching, learning and professional development with the Internet. New Zealand: University of Otago Press. (1999).

[4] Crossman, D.M."The evolution of the World Wide Web as an emerging instructional technology tool". In Khan, B.H. (Ed.). Web-based Instruction. New Jersey: Educational Technology Publications. (1997)

[5] Khan, B.H. "Web-based Instruction". New Jersey: Educational Technology Publications. (1997)

[6] Lai, K. W. "Net-Working : Teaching, Learning and Professional Development With the Internet". New Zealand: University of Otago Press.(1999)

[7] Ma, J. Huang, R & Shih, T.K. "The Concepts, Framework and Architecture of an Integrated Educational System for Virtual Universities". In Cumming G, Okamoto, T.,& Gomez, L. (Eds.) Advanced Research in computers and communications in Education. IOS Press. (1999).

[8] Radford, A.J. "The future of Multimedia in Education", First Monday, Issues 2 Volume 11 (1997)

[9] [illegible] (1999)

Designing A Web-Based Action Learning Environment - Integrating Learning and Working in One Environment

Feng-Kwei Wang* and John Wedman**
**University of Missouri - Columbia*
221-I Townsend Hall, Columbia, MO 65211, USA
Tel: +2-573-8843918
Fax: +2-573-8844944
wangfeng@missouri.edu
***University of Missouri - Columbia*
303-H Townsend Hall, Columbia, MO 65211, USA
Tel: +2-573-8824546
Fax: +2-573-8844944
wedmanj@missouri.edu

Action learning has become a popular approach to management education. Many advocates of "work while you learn and learn while you work" define action learning as an experience-based approach to developing workers by integrating real workplace problems and dilemmas in development programs as a way to work and learn concurrently. In tandem with the increasing acceptance of action learning, Web-based learning has become a common practice in both school and work settings. The authors contemplate that Web technology be utilized to build a Web-based action learning environment. In this environment, the tools and resources selected and devised are intended to facilitate the pedagogical processes of action learning. The biggest advantage of this environment is that learners are able to conduct action learning without constraining to time and space boundaries. The authors also argue that any technology-based learning environment would be flawed without a sound design framework and strong cultural and leadership supports for implementation.

Keywords: **Action Learning, Web-based Learning Environment, Knowledge Repository**

1 Introduction

Recently, learning based on socio-cultural theories such as situated learning [1] and cognitive apprenticeship [2] have gained attention in academic education and corporate training. There are three core doctrines of socio-cultural learning theories [2,3,4,5]. First, knowledge is situated in meaningful tasks that the learner carries out. Second, learning is a social process in which the learner interacts with peers or experts. Third, mediated tools and signs in the socio-cultural milieu of the learner affect learning processes and results. In other words, these theories hold that learning occurs in a socio-cultural context where the learner carries out authentic tasks. Thus, it becomes essential to combine working and learning contexts in the workplace if learning is to be effective. In parallel with the development of socio-cultural learning theories, action learning has become an emerging paradigm for workplace learning [6,7]. The tenet of action learning is learning through action [8,9]. In action learning, learners learn with and from each other, with the help of facilitators, by working on real problems and reflecting on their own experiences.

In addition to the emerging learning theory that has changed today's landscape of learning design and implementation, learning technology is another area that has a deep impact on the construction of learning environments. The technological advancements that the Internet and the Web have brought about have outpaced pedagogical and human learning theories [10]. The interactive, distributed, and collaborative features the Web offers present unprecedented opportunities for experimentation in creating an online learning environment that allows learning to occur without temporal and spatial constraints. Learning anytime, anywhere through the Web has become a common practice in the educational circle [11].

This paper intends to provide the design framework of a Web-based action learning environment (WALE) that combines contemporary learning theory and learning technology to facilitate and support the process of action learning. We begin with an overview of action learning and groupware technology, which a WALE is built upon. Then, we introduce the design framework of a WALE. We also present an actual WALE we built to give readers a better understanding of this WALE framework.

2 Action Learning

The concept of action learning made its appearance in 1954 as a method of problem solving. In 1967, Revans first implemented action learning in Belgium as a method of management development. Revans [12] defines:

> "Action learning is a means of development, intellectual, emotional or physical, that requires its subject, through responsible involvement in some real, complex and stressful problem, to achieve intended change sufficient to improve his observable behaviour henceforth in the problem field" (p. 4).

According to Revans [9], learning (L) is the sum of acquired programmed knowledge (P) and questioning insight (Q) and is denoted as:

$$L = P + Q$$

P represents the traditional instruction received in formal academic institutions such as business schools, and is deployed by experts. Q represents one's own findings from managerial experiences and is exercised by leaders. It should be noted that P and Q are complementary parts of a total development process [13, 14].

In a typical action learning program, programmed instruction might be given on a designated theory or theoretical topic. In conjunction with the programmed instruction, learners are asked to apply their prior and new knowledge to a real project that organizational sponsors have sanctioned. Throughout the program, learners continue to work on the project with assistance from qualified facilitators or advisors as well as other learners who help them make sense of their project experiences.

Action learning situates learners in a real-life problem in which they learn from and with others as they solve organizational problems. While there are many variations of action learning, Beaty, Bourner & Frost [15] argue that four essential elements of action learning are

* real problems,
* group reflection,
* personal responsibility, and
* action based

First, learners learn from tackling organizational problems they face within their work contexts. Second, learning is a social interaction in which learners learn with and from a group of others who are also engaged in managing real problems. Third, members of the group are accountable for solving their own organizational problems. Fourth, action learning does not stop with theoretical solutions. It is concerned with implementing the actions that the group has explored.

Action learning holds that learning for learners means learning to take effective actions [14], which only occurs when learners actually engage in taking actions. The best actions for learning are those that solve an organization's real problems, those actions that are significant to the learners themselves. The learning process is a social interaction in which a group of learners work together as a team on the problems. The learners learn best with and from one another through peer interactions and discussions.

"Action learning is holistic in its view of the person [learner], the management process, and learning. It is highly situational, flexibly treating elusive problems and combines a social process with individual needs" [14, p37]. Its value lies in the situated characteristics of knowledge and skills acquisition. Through hands-on experiences with peers in solving real-life problems, learners can develop their own theories of learning and management in action, which are tested against real-world experiences as well as established tenets [16]. Learners are able to sharpen their problem-solving, communication and critical-thinking skills and to build skills that are germane to their own particular organizational needs. Furthermore, action learning, in a broader sense, has much in common with the concept of the learning organization [14]. The critical features of action learning are in accordance with the five disciplines of the learning organization: system thinking, personal mastery, mental models, building a shared vision, and team learning [17]. From this perspective, action learning is not only a matter of individual learning and action but is also an organizational transformation process that deals greatly with organizational dynamics and culture.

3 Augmenting Action Learning with Technology

While action learning is taking off and is proven to be effective in management education [18, 19], we believe that Web technology can augment its effectiveness. First, the use of Web technology to communicate organizational information, to coordinate workflows, and to collaborate on work tasks becomes indispensable in solving today's organizational problems. Since action learning emphasizes that learning comes out of business actions, we believe Web technology is instrumental for learning, in that the common Web functions can concurrently support working and learning. Second, the most vital resource in action learning is the participants' own experiences and resources. The sharing of these experiences and resources often occurs only when participants convene in action learning meetings where the majority of problem diagnosis, group discussion, solution planning, and collective reflection take place. Consequently, these valuable experiences and resources are not captured, widely disseminated, or even lost outside action learning meetings or programs. Third, time and geographical boundaries often put constraints on where and when action learning meetings can occur. The communication functions of Web technology such as e-mail and online bulletin boards provide the means to break the limitations of space and time. These functions enable the continuity of learning process beyond face-to-face meetings. Furthermore, the collaborative features of Web technology can be used to engage people in the action learning process. Although well-designed action learning programs do a good job of involving participants in learning and action, the ability to let people collaborate anytime, anywhere creates an expectation that action learning is a collective effort and every participant is contributing.

4 Web-based Action Learning Environment

With the characteristics of action learning and Web technology in mind, we develop a framework for designing a Web-based action learning environment (WALE) as shown in Figure 1. In this framework, learning occurs when learners engage in action learning to solve organizational problems with the support of Web tools and resources. The tools and resources selected and devised for the learning environment are intended to facilitate the pedagogical processes of action learning. The design of action learning and technological support has to take into account the organizational context and should be constantly evaluated and improved accordingly. The Web tools and resources are devised into three categories: knowledge repository, collaborative tools, and cognitive tools.

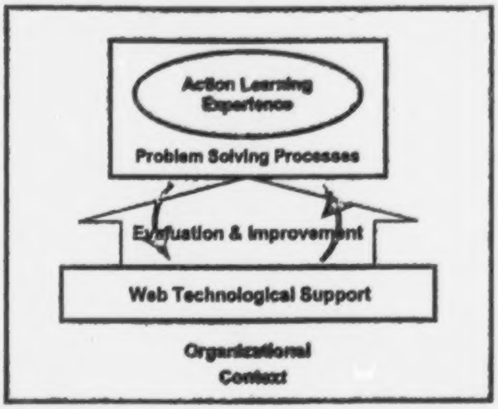

Action Learning Experience
Problem Solving Processes
Evaluation & Improvement
Web Technological Support
Organizational Context

Figure 1. The design framework of a Web-based action learning environment

4.1 Knowledge Repository

At the conceptual level, a knowledge repository is about capturing and preserving the theory and practice of practitioners in an organization. The theory component represents what Ravens called programmed knowledge (P). In action learning, there is much in theory that can inform action. For one thing, it allows practitioners to see problems in a new light. Further, it might even reveal problems undiscovered for lack of recognizable solutions. The practice component is Revans' Q that represents practitioners' own findings from their experiences. These experiences are transformational and knowledge-based in a way that is useful to an organization. They provide the means of organizational learning, from which organizational members can gain insight and understanding. In action learning, experiences edify the program participants' past success and failure of actions. They also provide the questioning insights upon which the participants can reflect and guide their future actions.

At the detailed level, a knowledge repository is a collection of electronic documents that contains basic concepts in a subject domain and extracted experiences from practitioners including cases, lessons learned, best practices, techniques, tips, references, and other knowledge granules with powerful searching functions and easy navigational tools.

4.2 Collaborative tools

Collaborative tools, which include computer conferencing, electronic mail, and shared workspace, are used to promote collaboration among participants in an action learning program. Participants take on problem solving collaboratively through this online environment built on computer networks. Through the networks, multiple perspectives and diverse learning approaches can be stimulated, with each reinforcing the others [20]. Computer conferencing permits the development of online, asynchronous, many-to-many person discussions. Electronic mail allows each participant to send messages relating to personal issues to a specific person or group [21]. Computer conferencing and electronic mail extend the time and space boundaries of action learning beyond action learning meetings and moves learning directly into the workplace. They enable action learning anytime, anywhere and make action learning an ongoing process. The shared workspace serves as the group memory, recording group activities and information in action learning. It is capable of tracking a participant's or a group's action patterns and learning paths, which indicates what actions have been performed and what information has been accessed. Each participant can either reflect on his or her own action learning history or can learn from others by reviewing the group processes.

4.3 Cognitive Tools

Kozma [22] explains that the computer can alleviate the learner's information processing burden, thereby extending human cognition. In case problem solving activities, computer tools are used to ease and enhance the performance of cognitive tasks. Such tools in a WALE include performance support, hypermedia, and navigation functions. First, performance support functions are a set of Web tools or electronic job aids that participants use to facilitate problem solving. These functions ease the cognitive load of many arduous but necessary work and/or learning tasks and make learning and problem solving more efficient. The use of problem diagnosis forms and online action learning guidelines are two examples. Second, in a hypermedia environment, knowledge is purportedly organized by mirroring the structure of human thinking. The process of imitating human thinking proceeds through associating one piece of information to a related piece of information. It functions as "knowledge on demand" and exhibits the capacity to branch from one thought to related knowledge or experiences [23]. That being so, an appropriately structured hypermedia system should be able to mirror the semantic network of an experienced or knowledgeable performer or expert [24]. Third, navigation functions such as searching, navigation maps, indices, history, and bookmarks prevent learners from getting lost in the spacious knowledge ocean and point participants in the right direction. Navigating with such tools quickly brings participants the part of knowledge that they are looking for. Navigation maps show where participants are and where they have been in knowledge repository. Similarly, indexes offer participants different ways of identifying and viewing knowledge. In contrast, the history function keeps track of navigational paths and allows participants to trace their learning processes. Finally, bookmarks register particular knowledge locations for later quick access.

5 Learning and Working in a WALE

From the process standpoint, building a WALE encompasses a set of interrelated processes that engage participants in the problem-solving activities. These processes become a way of identifying and understanding interrelated factors while helping fill gaps, minimize redundancies, and eliminate conflicts toward common goals. They enable participants to develop themselves by building, reflecting on, renewing, and sharing what they know and how they do things in solving organizational problems. In this way, a WALE integrates learning and working in one environment through: 1) online action learning activities with peers and facilitators, 2) the utilization of Web-based learning and performance support tools, and 3) full-time access to problem solving resources and results (see Figure 2).

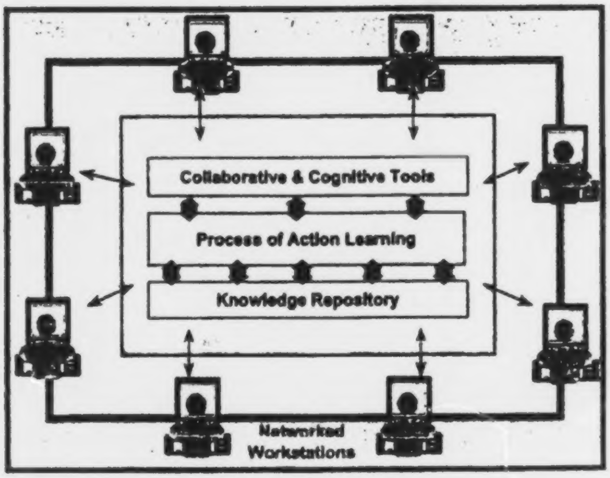


Figure 2. Working and Learning simultaneously in a WALE

6 A Case in Point

Teacher education programs have been challenged to respond to advances in technology. Unfortunately, these programs are criticized for not adequately preparing teachers to use technology in their teaching. The Office of Technology Assessment (1995) reported on technology in teacher education and noted significant limitations, including 1) faculty not modeling technology use; 2) students learning about technology – not with it; 3) field experiences not designed to model the use of technology; and 4) technology isolated from the main curriculum and pedagogy of teacher education. These limitations point to the need to revamp teacher education programs at many universities.

While teacher education faculty are central to the problem and its eventual solution, individual faculty are typically powerless to address these limitations. Deans, Directors of Teacher Education, Department Chairs, and other college and school-level leaders are best positioned to make a response, but seldom are these individuals prepared to deal with the many complexities, technical and otherwise, creating barriers to integrate technology in teacher education. Moreover, the rate of technological changes makes technology integration in teacher education a perpetual endeavor. Learning to solve problems means taking action in solving problems.

Funded by a grant from the U.S. Department of Education, a consortium of teacher education programs at the Universities of Missouri, Nebraska, Oklahoma, and Kansas, and Texas A&M was established to tackle many similar problems found in integrating technology in teacher education. This consortium is grounded with a common vision: teachers and students enabled by new and emerging technology and building a better future for all. The common mission is to better educate future generations of teachers to use technology. Recognizing that accomplishing the mission is an ongoing endeavor and the means to the end is constantly in flux due to fast emerging technology innovations and student needs, the leaders of consortium programs take the action learning approach to prepare themselves and their programs.

Adopting the WALE framework, the consortium, led by the University of Missouri, initiated a WALE development project to deploy a knowledge repository to support action learning programs engaged by respective consortium members. The Technology Integration Process (TIP) knowledge repository captures, organizes, and disseminates the collective knowledge about technology integration in teacher education, thereby leveraging the professional knowledge across many programs. Figure 3 shows the entry screen of the TIP system.

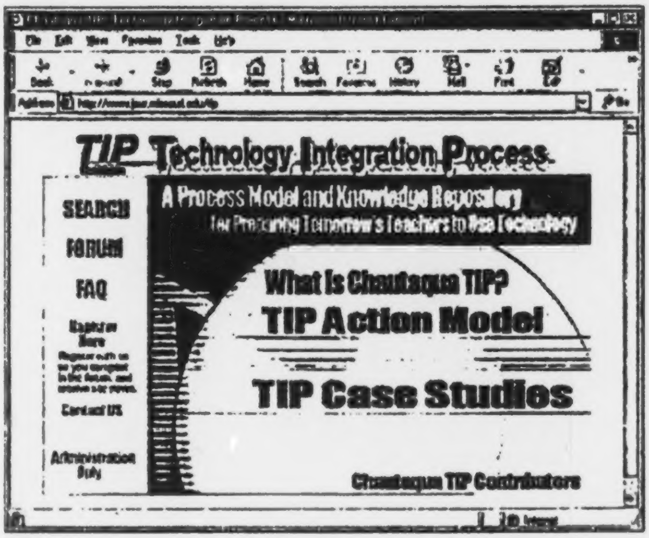

File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit
TIP Technology Integration Process
A Process Model and Knowledge Repository
for Preparing Tomorrow's Teachers to Use Technology
SEARCH
FORUM
FAQ
Contact US
What Is Chautaqua TIP?
TIP Action Model
TIP Case Studies
Chautaqua TIP Contributors

Figure 3. The entry screen of the TIP system

BEST COPY AVAILABLE

To start with, the TIP design includes a process model for technology integration in teacher education. The model consists of five inter-related processes: research, design, development, delivery, and evaluation. Two or more subprocesses were identified for each process. This TIP action model represents the P component of Ravens' learning model: the theory of technology integration in teacher education. To capture the TIP experiences (the Q component) of participating programs, dedicated project staff was sent to collect knowledge about TIP actions in each participating program. These experiences categorized according to five TIP processes were written as descriptive documents enhanced by multimedia elements. Each experience is titled as a TIP case and can be searched by name, by category, and by program as well as through a full-text search engine spanning the entire database.

Following the action learning approach, knowledge collection at each participating program began with a two-day self-study facilitated by the project facilitator. The self-study process opened with an orientation to the goals of the project and a demonstration of the knowledge repository from the functional and conceptual perspectives. Attention then turned to identification of the strengths and limitations of the program in relationship to the elements of the TIP action model. More site visits followed for problem diagnosis and solution implementation. In these follow-up meetings, in light of presented problems with the program and illuminating TIP cases in the system, the participants reflected upon the problems and solutions to develop action plan. It was then up to the participants of each program to carry out the plan. In the meantime, project staff continued the tasks of TIP knowledge discovery and collection and preserved the knowledge in the system that also facilitates the information exchange and knowledge dissemination throughout project lifespan. Individuals from participating programs are periodically notified when new knowledge (i.e., documents) was added to the system. Also, notifications are sent out when a new threaded discussion is initiated or when existing discussions are active. In this way, TIP action learning becomes an ongoing and collective effort from all contributing partners of this consortium.

7. Conclusion

The utilization of the Web for action learning is one possible efficient and effective way to leverage the intellectual capital of an organization in solving organizational problems. In this paper, we have laid out the design framework of a Web-based action learning environment. We illuminate our design with an actual WALE that we built to integrate technology in teacher education. We also understand a successful WALE is more than a design framework and a new technology implementation. While Web technology may have the advantage of removing boundaries of space and time to facilitate and enhance action learning, it may cause other difficulties by eliminating ordinarily desirable interpersonal communication channels necessary for effective action learning. Our experience has shown that the successful application of a WALE relies upon a judicious marriage of a sound design of Web technological tools and resources and inner strengths of participants, with reflections upon learnings from experiences of action in the real world of work and life. It must focus on critical successful factors that include fostering a conducive learning culture, marshaling true leadership support, deploying a nurturing process model, and sustaining the change throughout the organization. Also, it must move us to a view that sees learning in the context of the workplace so that higher individual and organizational performance can be achieved.

References

[1] Lave, J. & Wenger, E. "Situated learning: Legitimate peripheral participation", New York: Cambridge University Press, (1991).
[2] Brown, J. S., Collins, A., & Duguid, P., "Situated cognition and the culture of learning. Educational Researcher", Vol. 17, pp. 32-42, (1989).
[3] Bonk, C. J. & Kim, K. A., "Extending sociocultural theory to adult learning", In Smith, M. C. and Pourchot, T. (Eds.), Adult learning and development: Perspectives from educational psychology, Mahwah, NJ : Lawrence Erlbaum Associates. (1998).

[4] Tharp, R., & Gallimore, R., "Rousing minds to life: Teaching, learning, and schooling in a social context", Cambridge, MA: Cambridge University Press, (1988).

[5] Wertsch, J. V. "Voices of the mind: A sociocultural approach to mediated action", cambridge, MA: Harvard University Press, (1991).

[6] McLaughlin & Thorpe. R., "Action Learning: A Paradigm in Emergence", British Journal of Management, Vol. 4., No. 1., (1993).

[7] Yorks, L., "The emergence of action learning", Training & Development, Vol. 54, No. 1, pp. 56-56. (2000).

[8] McGill, I. & Beaty, L. "Action learning: A guide for professional, management and educational development", London, UK: Kogan Page, 2nd Edition (1995).

[9] Revans, R., "Action learning: New techniques for action learning", London, UK: Blond and Briggs, (1983).

[10] Salomon, G., "Novel constructivist learning Environments and novel technologies: Some issues to be Concerned with. Research Dialogue in Learning and Instruction", Vol. 3, No. 1, pp. 3-12, (1998).

[11] Morris, K., "Wiring the ivory tower", Business Week, pp. 90-92. (1999, August 9).

[12] Revans, R., "The nature of action learning", Management Education and Development, Vol. 10, No. 1, pp. 3-23. (1979).

[13] Korey, G. and Bogorya. Y., "The managerial action learning concept-theory and application", Management Decision, Vol. 23, No. 2, pp. 3-11, (1985).

[14] Mumford, A., "Learning in action", Personnel Management, Vol. 23, No. 7, pp. 34-37, (1991).

[15] Beaty, L., Bourner, T., & Frost, P., "Action learning: reflections on becoming a set member", Management Education and Development, Vol. 24, No. 4, pp. 350-367, (1993).

[16] Marsick, V. J., "New paradigms for learning in the workplace", In V. J. Marsick (Ed.), Learning in the workplace (pp. 11-30). New York: Croom Helm, (1987).

[17] Senge, P. M., "The fifth discipline: The art and practice of the learning organization", New York: Doubleday/Currency, (1990).

[18] Froiland, P., "Action learning: Taming real problems in real time", Training, Vol. 31, No. 1, pp. 27-34, (1994).

[19] Keys, L., "Action learning: Executive development of choice for the 1990s", Journal of Management Development, Vol. 13, No. 8, pp. 50-56, (1994).

[20] McCarthy, R., "Multimedia: What the Excitement's All about", Electronic Learning, Vol. 8, No. 8, pp. 26-31, (1989).

[21] Harasim, L. M., "Global Networks: An Introduction", In Linda, L. M. (Ed.) Global Networks: Computers and International Communication. Cambridge, MA: The MIT Press, pp. 3-13, (1993).

[22] Kozma, R., "The Implications of Cognitive Psychology for Computer-based Learning Tools", Educational Technology, Vol. 27, pp. 20-25, (1987).

[23] Amthor, G., "Interactive Multimedia in Education: Concepts and Technology, Trends, and Model Applications, Megamedia and Knowledge Systems", T.H.E. Journal, Special Issue: IBM Multimedia, pp. 2-11, September, (1991).

[24] Jonassen, D. H., "Acquiring Structural Knowledge from Semantically Structured Hypermedia", A paper presented in the AECT annual convention, Washington, D.C, (1992).

Developing a research instrument for measuring the effectiveness of Web-based learning materials

Eugenia M. W. Ng* and Wing Kee Au**
Department of Information and Applied Technology
The Hong Kong Institute of Education
10 Lo Ping Road, Tai Po, N.T.
Hong Kong SAR, China
Tel: +852 2948 7645, Fax: +852 2948 7726,
*E-mail: *eugenia@ied.edu.hk, **wkau@ied.edu.hk*

The World Wide Web (Web) is growing at an exponential rate and has been adapted to learning free from constraints of time and place around the globe. Increasing resources have been devoted into developing Web-based learning materials (WBLM) worldwide. Although some researchers had proposed guidelines for designing Web-based instructions, most WBLM are primarily designed by the course co-ordinators. This phenomenon could be problematic especially when there is little empirical research investigating the perceived factors affecting the effectiveness of WBLM. Thus, the main research objective of this study is to develop a survey instrument to evaluate the critical factors which might affect the effectiveness of WBLM. This research comprises four phases. This paper reports the findings of the first phase. Interviews, focus group meetings and questionnaires were adopted to develop the measuring instrument. Focus group meetings were conducted to solicit opinions from academic and technical experts on the critical factors affecting the effectiveness of WBLM. Their viewpoints on course management, user interface, technical considerations, content features and assessments were summarized and presented in this paper. The future research plan which will lead to the development of a refined questionnaire will also be discussed.

Keywords: **World Wide Web, Web-based learning materials, survey instrument**

1 Introduction

The World Wide Web (Web) is increasingly being used as a vehicle for flexible learning, where learning is seen to be free from time, geographical, and participation constraints [27, 33]. Many tertiary institutions invest considerable resources in the Web to deliver pedagogical materials to learners who have a diversity of needs and backgrounds, many of these learners take courses whilst working full-time or part-time and/or raising a family. In addition to flexibility, the Web facilitates student-centered approaches, creating a motivating and active learning environment [3]. There are suggestions that, in providing for browsing and thematic exploration, the Web facilitates higher order cognitive processes, such as transfer and knowledge application [15]; whilst at a more conceptual level, there has always been a case made for hypertext mirroring the ways in which much of human thinking occurs, by association rather than linearly or procedurally [4].

On the practical side, the Web not only provides economic and powerful resources, it also opens up an alternative arena for learning as it permits the work of individuals to be shared with the world, and much content of the Web cannot be found in any other format [11]. Kearsley [19] elaborated on the attributes of the Web, "[T]he most significant aspect of the Web for education at all levels is that it dissolves the artificial wall between the classroom and their "real world". (pp. 28). However, Marchionini [24] argued that most students did not make appropriate use of hypertext system because they were still using mental models of print versions of encyclopaedias. Similarly, many learners do not necessarily make use of valuable resources available to them [9] and they do not possess the appropriate metacognitive ability to monitor their learning processes [5]. Research also showed that learners did not utilize the available choices most effectively because they were unable to appropriately monitor their cognitive functions [8]. As a consequence, learners may find it difficult to adjust to this new learning environment [25].

It is apparent that the Web itself is only a medium for conveying information. Hypermedia is frequently adopted to transmit the information on the Web and yet it does not possess a single or normative information structure. The structure might be highly ordered, supported by a constrained and sequential set of links or the hypermedia may be nonsequential and supported only by referential links. In many cases, a Web site might comprise a mix of these structures. It is often the nature and application of these structures that determine the effectiveness of carrying and delivering Web-based learning materials (WBLM). Very often paper-based information resources are converted into "electronic page-turning" materials for Web-based learning (WBL). There is little regard for appropriate pedagogic design models and strategies for exploiting the Web as a learning medium [1, 31, 35]. Most WBLM are designed by the course coordinators with a view to covering the content rather than on improving learning outcomes [6]. While many learners might possess the basic information and navigational skills to access information on the Web, instructional designers have yet to consider those aspects of this medium that determines its effectiveness for all learners.

Some researchers perceived the importance of Web-based instruction (WBI) and have proposed guidelines for designing it (for example, [6, 20, 28]). Words, numbers, graphs and pictures (animated or non-animated) are often used to communicate visually. Text leads readers along a particular train of thought [17]. Animations were thought to make user interfaces easier to use, more enjoyable, pleasurable and understandable [2, 32]. Jones [16] explained how the relationship between instructional design and world views had molded and was molded by contemporary symbolic and materials culture artifacts and concluded the form of cultural artifacts, in the case of computer graphics, expressed our symbolic relations with the world and influences how we constantly (re)inventing ourselves. Reeves [30] had identified fourteen dimensions to judge the pedagogic worth of interactive multimedia (IMM) instructional design, and Henderson [13] argued an instructional design cannot and does not exist outside of a consideration of culture. Yet there is very little information on how to create an interface for instructional purposes [18, 23]. Since it is very costly, in terms of human, time and financial resources, to develop WBLM, it is imperative that a validated survey instrument be developed to assess the effectiveness of WBLM to enhance learning effectiveness.

2 The importance of developing a survey instrument

Survey is a popular research approach used in information systems research and is also gaining importance in recent years [10]. Kraemer and Dutton [22] commented that survey was ill suited for addressing the subtle dynamics of information technology in complex social settings. Galliers [7] thought this approach revealed little information in the underlying meaning of data and there might be possible bias in the respondents, researchers and the moment in time when the research was conducted. However, Porter [29; p. 289] argued that " surveys can add dimensions to our understanding of the kinds of problems we are studying". King [21] suggested survey research could play a major role in exploratory investigations. Survey has been chosen for this research not because it is the tool most suited but rather because of a lack of a better method.

3 The study

Despite the popularity of survey, poorly designed and executed survey is of little or no value. Survey instrument must be validated before being adopted fully. This research comprises four phases. Interviews, focus group meetings and questionnaires have been adopted to develop the measuring instrument. In the first phase, interviews and focus group meetings were conducted to solicit opinions on the critical factors affecting the effectiveness of WBLM. Interview is the most widely applied technique for conducting systematic social inquiry [14]. Interviews provide us with a means for exploring the points of view of our research subjects [26] and generate data which give an authentic insight into people' s experiences [34]. In the second phase, an initial questionnaire will be furnished from ideas generated from the focus group meetings and from in-depth literature review. In the third phase, the questionnaire will be pilot-tested and follow-up interviews will be conducted to refine the items of the questionnaire. In the fourth and last phase, a refined questionnaire will be developed. This refined questionnaire will be used to gather quantitative data from a large sample and these data can form a data bank for future referencing.

This paper reports the findings of the first phase. An in-depth interview was conducted in February and three separate focus group meetings were carried out in March 2000. The interviewee, Julie Ziller, was an expert in Web-based design from Canada whilst all the participants of the focus group meetings were staff of the Hong Kong Institute of Education. The first meeting was attended by academic colleagues who had some experience in developing WBLM or computer-assisted learning materials. The second meeting was attended by technical colleagues who had experiences developing WBLM whilst the third meeting was attended by both academic and technical colleagues who were not available to attend the first two meetings. There were a total of fifteen participants who attended the meetings. The researchers, assisted by a research assistant, acted as facilitators to prompt participants during brain-storming sessions. The facilitators guided participants to put forward factors related to the content, graphical user interface, assessments and course management [12] which might affect WBLM. All the meetings were tape-recorded and the main points were transcribed.

4 Findings

In general, the academic colleagues had more concerns on the technical aspects of the design whilst the technical colleagues had more concern on the content of the Web sites. Some participants believed that the nature of a course might be a factor affecting Web-based learning. The participants believed that the course designers should have a clear notion of why they chose the Web as the medium of instruction and if it was the right medium to deliver the specified course materials. When the Web was considered the best medium or could provide an alternative medium of instructions, the course designers have to consider if the learners possess the necessary software, hardware and skills to access to the WBLM. Their detailed discussions concerning course management, technical considerations, content features, user interface design, interactions and assessment are encapsulated below.

4.1 Course management

Participants suggested that an introductory seminar should be organized to enhance learners' understanding on the course objective, the course material, and the learning environment on Web. As many learners may not be familiar with learning from online material, hard copies of study guide or reference lists and content lists should be provided as supplementary materials. This was deemed to be essential in helping learners to step into a Web-based learning environment.

4.2 Technical considerations.

The design of the WBLM should allow for a wide range of equipment required and bandwidths. Several versions of Web pages should be provided for different transmission rates, for example, HTML, Flash and multimedia versions. Although participants believed that broadband would be common within two to three years, course coordinators should consider that the majority of learners are using narrow band currently. Except for the main page, transmission time from page to page should preferably be in a few seconds.

4.3 Content features

Since the purpose of this study is to develop a general survey instrument, no specific content was considered. The features of WBLM, like text/documents, hyperlinks to related materials, chat rooms, discussion forums, assignments, home button, previous button, next button and so on, were basic features of a WBLM's interface and will not be covered here. All contents shown must mean what it is – learners must not be made to guess. Some academics at the focus group meetings thought that rich resources existed on the Web and these should facilitate learning. Some believed courses designed to teach skills rather than concepts could be better delivered through the Web. Statistical counts and logs were recommended as indicators for future enhancement of the Web contents or design. For example, the most popular sections/pages, the most common errors in assignments, the average reading time, and so on should be tracked. These counts could assist course coordinators when they needed to amend the instructional materials from time to time.

4.4 User interface design

Participants agreed that user interface was important. They were concerned with the diversity of learners' perception which exist in different societies and how a framework or design can cater for this diversity. The interface should be easy and comfortable to use. Each Web page should not have too much text within one or two paragraphs. The contrast of text and background in color should be distinct. Different font sizes were suggested to differentiate the importance of information. They also criticized that many Web Sites' printing function and settings were poor - they were not convenient for learners to use – requiring users to select and to set up printing functions.

Site map - An academic suggested that there should be a site map on the home (main) page to facilitate an understanding of the overall structure of WBLM.

Multimedia - Some participants mentioned that multimedia offered a distinct advantage of delivery on the Web especially for demonstration purposes and suggested that animated graphic should be used to enhance learners' memory; video and sound should be used in different sections of the Web. However, others thought that these features might affect learners' concentration. It had been suggested that learners should be able to play back/ repeat multimedia materials easily and it would be better if learners could control the speed and timing. Furthermore, if learners could search for any piece of information from the multimedia files just like in the text environment, it could reinforce their learning. Parts of or all the multimedia materials could be stored on a CD-ROM to reduce the transmission effort and time.

Hyperlinks - During the meeting, participants suggested that learners could be given some supportive information through "help" or hyperlinks. There were different viewpoints on hyperlinks though these were considered to be very usual tool for WBL. Some participants expressed that too many hyperlinks embedded in a Web Page could distract learners from concentrating on theirs studies, i.e. there should not be too many hyperlinks in a page. However, when there were valuable ideas not directly related to the actual contents, course coordinators could recommend them to learners. Another approach was that, the hyperlinks could be classified into different categories according to coordinators' opinion, hit counts, or learners' comments. The learners could be encouraged to post recommended references and top 10 reading hyperlinks were to be updated regularly.

Scroll bars - Participants had strong views on using the scroll bar - using left and right scroll should be discouraged, whilst using up and down scroll should be handled carefully. Correspondingly descriptive dialogue should appear over the bar while learners were using the scroll bar. Learners should be able to click out different sections easily. The contents table and searching tool should be placed on the left side of the Web page. In order to maintain learners' interests and to keep them informed when downloading, it was suggested that the learners should be informed instantly when such an action was triggered.

Interactions - The participants believed that interactions were important to make WBLM effective. They were concerned about how to build up interactions between coordinators and learners, among learners, and between learners and WBLM. They had suggested varieties of methods to promote interactions, such as hands-on periodic on-line assignments, on-line multiple-choice as a checkpoint, discussion forums, chat rooms and e-mails. Learners' participation could be stimulated if they are frequently prompted to discuss open-ended questions on discussion forums. Their motivation would be reinforced by coordinators' responses especially when the responses were quick. However, discussion forums might not be sufficient to build up a close relationship between learners and coordinators and among learners as learners were not accustomed to this kind of discussions. Furthermore, the reliability of information posted on the discussion groups had been doubted.

Recording function - The group suggested that a record sound function should be added to the Web pages. When learners have questions, they could speak and record their problems directly instead of writing them in text format. Similarly, the coordinator could play back these recorded questions and reply in voice as well.

Assistance – There should be assistance buttons such as "Help" to be placed at the bottom part of a Web Page and all linked pages

4.5 Assessments

Most participants agreed that WBL offers the ideal environment for continuous assessment and self progress monitoring. Assessments could be held on-line or off-line. Participants were concerned about the authenticity if assessments were on-line. Some participants argued that users could concentrate more in an interactive learning/assessing environment, such as answering several short questions within sections, then followed by an assignment within chapters. Some participants believed that the style of quizzes should be presented in a friendly manner. There should not be too many quizzes, otherwise, the learning pace might be slowed down. The balance between on-line and off-line assessment should be considered carefully.

5 Conclusion and further research plan

This paper has discussed the findings of the first phase of a project to develop a survey instrument for measuring the effectiveness of Web-based learning materials. Various key elements which facilitate and impede WBL were identified. The findings form the basic items of a survey instrument. The appropriateness of the items to the domain of the construct will be assessed. It can be done through considerations of the theoretical basis for the items in the literature or a panel of experts who are well versed with the domain. Experts are asked to separate items that are relevant to the domain from those that are not. After sorting, similar items will be eliminated to come up with a reasonable length of the instrument. Following the development of the preliminary instrument, pre-testing with users will lead to the second phase of this project.

5.1 Second Phase

This phase is to pre-test the instrument created in phase one. A pilot test on the survey instrument will be conducted from a representative sample size of the population under study to purify the measure. The participants will give their opinion on each questions based on the Likert scale, ranging from strongly disagree to strongly agree. The researchers, assisted by research assistants, will also interview the respondents to gather further opinions on the questionnaire such as the wording, length and instructions of the questionnaire. The aim is to ensure that the mechanics of compiling the questionnaire would be correct and adequate.

A further study will then be conducted with more respondents using the refined questionnaire. Similarly, participants will be asked for comments to improve the questionnaire. The aim is to make an initial reliability assessment of the questionnaire. It is essential that the instrument developed must be valid and reliable. There are several methods for investigating the validity of an instrument, including content, criterion and construct approaches. The most important element is construct validation, namely, factor analysis, will be used to establish construct validity. If the items for each variable load together in factor analysis but do not cross load onto other variables, there is evidence of construct validity. The items are also grouped by the factor (dimension) they are loaded on. Those factors under minimum acceptable loading will be discarded.

5.2 Third Phase

This phase consists of validating a research instrument through surveys and interviews similar to the second phase. Participants will be asked to rate each question using a refined instrument at the beginning and at the end of the semester. Some of them will also be interviewed. Convenient participants who take courses taught by the researchers or their associated colleagues will participate in this stage of a study. The purpose of conducting this survey is to understand if there are any differences among participants of different programs at different time frame. The results will be compared and contrasted to explore if there is any statistically differences among the learners from different programs and if there is statistically differences at the beginning and at the end of a semester.

5.3 Fourth Phase

This phase consists of re-validating the measuring instrument and establishing the norm if the instrument is validated. However, this stage will be to refine and modify the instrument if the questionnaire is found to be not valid. If the questionnaire is found to be valid, the same instrument will be distributed to a larger sample of about sixty participants. The larger sample can further validate the instrument and provide additional evidence of reliability and validity. The same participants will be asked to rate the survey instrument again which is to be used as a confirmative measure. Other learners in a much wider context will also be surveyed so as to form a more reliable data source. Quantitative analysis will be performed to find out if there is any difference between the demographics of learners such as gender, level of studies, areas of studies versus the items of the instrument. The re-validated instrument and research findings can then be used as a norm for future research and development.

References

[1] Alexander, S., "Teaching and learning on the World Wide Web", Paper presented at AusWeb95: The First Australian World Wide Web Conference, Southern Cross University, New South Wales, 30 April - 2 May, (1995).

[2] Baecker, R. M., Small, I., "Animation at the Interface". In B. Laurel (Ed.), The Art of Human-computer Interface Design (pp. 251-268), Reading, MA: Addison-Wesley, (1990).

[3] Becker, D., & Dwyer, M., "Using hypermedia to provide learner control", Journal of Educational Multimedia and Hypermedia, Vol. 3, No. 2, pp. 155-172, (1994).

[4] Burton, J. K., Moore, M., & Holmes, G. A., "Hypermedia concepts and research: An overview", Computers in Human Behaviour, Vol. 11, No. 3 & 4, pp. 345-369, (1995).

[5] Cho, Y., "The nature of learners' cognitive processes in learner-and program-controlled hypertext learning environments", Unpublished doctoral dissertation, University of Texas at Austin, (1995).

[6] Dillon, A., and Zhu, E., "Designing Web-based instruction: A human-computer interaction perspective", In B. H. Khan (Ed.), Web-Based Instruction (pp. 221-224) Englewood Cliffs, NJ: Educational Technology Publications, (1997).

[7] Galliers R. D., "Choosing information systems research approaches", In R. D. Galliers (Ed.), Information Systems Research - Issues, Methods and Practical Guidelines (pp. 144-162) Blackwell Scientific Publications, (1992).

[8] Garhart, C., & Hannafin, M., "The accuracy of cognitive monitoring during computer-based instruction", Journal of Computer-Based Instruction, Vol. 13, No. 3, pp. 88-93, (1986).

[9] Gay, G., Trumbull, D., & Mazur, J., "Designing and testing navigational strategies and guidance tools for a hypermedia program", Journal of Educational Computing Research, Vol. 7, No. 2, pp. 189-202, (1991).

[10] Grover, V., Lee, C. C., and Durand, D., "Analyzing methodological rigor of MIS survey research from 1980-1989", Information & Management, Vol. 24, pp. 305-317, (1993).

[11] Hackbarth, S., "Introduction to special issue on Web-based learning", Educational Technology, Vol. 37, No. 3, pp. 5-7, (1997).

[12] Hansen, L, and Frick, T. W., "Evaluating guidelines for Web-based course authoring systems", In B. H. Khan (Ed.), Web-Based Instruction (pp. 299-312) Englewood Cliffs, N.J.: Educational Technology Publications, (1997).

[13] Henderson, L., "Instructional design of interactive multimedia: A cultural critique", Educational • Technology Research and Development, Vol. 44, No. 4, pp. 86-104, (1996).

[14] Hyman, H. H., Cobb, W. J., Feldman, J.J., Hart, C. W., and Stember, C. H., "Interviewing in Social Research", Chicago: University of Chicago Press, (1975).

[15] Jacobson, M., & Spiro, R., "Hypertext learning environments, cognitive flexibility and the transfer of complex knowledge", Journal of Educational Computing Research, Vol. 12, No. 4, pp. 301-333, (1995).

[16] Jones, B., "Cultural maintenance and change", Media Information Australia, 69 (August), pp. 23-37, (1993).

[17] Jones, C. V., "Visualization and Optimization", Norell, MA: Kluwer Academic Publishers, (1996).

[18] Jones, M.G., Farquhar, J.D., & Surry, D. W., "Using metacognitive theories to design user interfaces for computer-based learning", Educational Technology, Vol. 35, No. 4, pp. 12-22, (1995, July – August).

[19] Kearsley, G., "The World Wide Web: Global access to education", Educational Technology Review, Winter No. 5, pp. 26-30, (1996).

[20] Khan, B. H., "Web-Based Instruction (WBI): What is it and why is it?", In B. H. Khan (Ed.), Web-Based Instruction (pp. 5-18) Englewood Cliffs, N.J.: Educational Technology Publications, (1997).

[21] King, J. L., "Commentary" In K.L. Kraemer (Ed.), J. I. Cash, Jr., and J. F. Nunamaker, Jr. (Series Eds.), The Information Systems Research Challenge: Survey Research Methods, 3 (pp. 291-29). Harvard Business School Research Colloquium, Boston, MA.: Harvard Business School, (1991).

[22] Kraemer, K. L., and Dutton, W. H., "Survey research in the study of management information systems", In K.L. Kraemer (Ed.), J. I. Cash, Jr., and J. F. Nunamaker, Jr. (Series Eds.), The Information

Systems Research Challenge: Survey Research Methods, 3 (pp. 3-57), Harvard Business School Research Colloquium, Boston, MA.: Harvard Business School, (1991).

[23] Lohr, L., "Development of a procedure for GUI design". In R. E. Griffin, W. L. Gibbs, & B. Wiegmann (Eds.) Visual literacy in an information age: Selected readings from the Annual Conference of the International Visual Literacy Association (pp. 225-233). Blacksburg, VA:IVLA, (1999).

[24] Marchionini, G., "Making the transition from print to electronic encyclopaedias: Adaptation of mental models", Journal of Man-Machine Studies, Vol. 30, pp. 591-618, (1989).

[25] McCombs, B. L., "Motivation skills training: combining metacognitive, cognitive, and affective learning strategies", In C. E. Weinstein, E. T. Goetz, and P. A. Alexander (Eds.), Learning and Study Strategies: Issue in Assessment, Instruction, and Evaluation (pp. 141-165) San Diego: Academic Press, (1988).

[26] Miller, J., and Glassner, B., "The ' inside' and ' outside' finding realities in interviews", In D. Silverman (Ed), Qualitative Research, Theory, Method and Practice, (pp. 99-112) London: Sage, (1997)

[27] Nguyen, A. T. A., Tan, W., & Kezunovic, L., "Interactive multimedia on the World Wide Web: Implementation and implications for the tertiary education sector", In M. Nott (Ed.), Proceedings of AusWeb96: The Second Australian World Wide Web Conference. Gold Coast, Australia: Southern Cross University, (1996).

[28] Nielsen, J., "Top Ten Web Design Mistakes, Jakob Neielsen' s Alertbox for May", [On-line] Available http://www.useit.com/alertbox/9605.html, pp. 1-3, (1996).

[29] Porter, L. W., "Commentary to methodological issues in information systems survey research", In K.L. Kraemer (Ed.), J. I. Cash, Jr., and J. F. Nunamaker, Jr. (Series Eds.), The Information Systems Research Challenge: Survey Research Methods, 3 (pp. 287-289), Harvard Business School Research Colloquium, Boston, MA.: Harvard Business School, (1991).

[30] Reeves, T., "Effective dimensions of interactive learning systems", Information Technology for Training and Education Conference (ITTE' 92) St. Lucia, Brisbane: University of Queensland, September-October, pp. 99-113, (1992).

[31] Reeves, T., "A model of the effective dimensions of interactive learning on the world wide web", In P. Carlson & F. Makedon (Eds.), Interactive multimedia and hypermedia, 1996 Charlottesville, VA: AACE, (1996).

[32] Robinson, E. P., Jr., Gao, L., and Muggenborg, S.D., "Designing an Integrated Distribution System at DowBrands, Inc.", Interfaces, Vol. 23, No. 3, pp. 107-117, (1993).

[33] Rossman, P., "The emerging worldwide electronic university: Information age global higher education", Westport: Greenwood Press, (1992).

[34] Silverman, D., "Interpreting qualitative data: Methods for analysing talk, text and interaction", London: Sage, (1993).

[35] Wild, M., "Invited Presentation: The future of flexible learning and the use of technologies in tertiary education", Open Learning Seminar, University of Technology, Sydney. 15 July, (1996).

Acknowledgements

We are very thankful to all the participants and our research assistant, Miss Judy Mok, for their support to this research study. We are also grateful for the Hong Kong Institute of Education' s financial support for this project RG4/1999-2000.

Developing a Web Concordancer for English as Foreign Language Learners

Howard Hao-Jan Chen
Division of Foreign Languages
National Taiwan Ocean University
2, Pei-Ning Road, Keelung, Taiwan 202.
E-mail: b0240@mail.ntou.edu.tw

Quite a few tools and techniques of corpus linguistics have been applied to foreign language teaching and learning. One of the most popular learning tools is the concordancer. It helps language learners to efficiently uncover hidden linguistic patterns in large amount of data and to answer their own questions about the target languages. This type of data-driven language learning has been highly recommended by second language teachers and researchers. However, good concordancing programs and suitable corpora in fact are not widely accessible for second language learners, so many learners cannot participate in data-driven learning. As Internet/World-Wide-Web has become the best platform for distributing educational resources, a web concordancer will provide a data-driven learning environment to students from anywhere at anytime. This paper first reviews several web-based concordancers for ESL/EFL learners (CobuildDirect Corpus Sampler, Hong-Kong Polytechnic Web Concordancer, and Web Concordancer for Gutenburg texts). Then the strengths and weakness of each of these web sites are identified and compared. The last section describes how language faculty at National Taiwan Ocean University (NTOU) develops a web concordancer for Taiwanese EFL learners. It is expected that this web concordancer will be able to provide Taiwanese EFL learners a fast, reliable, and user-friendly environment for data-driven learning.

Keywords: **Web-based English Learning, Data-Driven Learning, Concordancer**

1 Introduction

1.1 Corpus and Concordancer

Linguists working in the Chomskyian paradigm have been using native speakers' intuitions as the key data for linguistic research. More recently, some linguists no longer rely on their intuitions as the main data source, and they have also begun to analyze large amount of written and spoken texts (i.e., corpus) to uncover hidden linguistic generalizations. McArthur & McArthur [7] provided a very clear explanation regarding corpus and corpus linguistics.

> CORPUS [13c: from Latin corpus body. The plural is usually corpora]. (1) A collection of texts, especially if complete and self-contained: the corpus of Anglo-Saxon verse. (2) Plural also corpuses. In linguistics and lexicography, a body of texts, utterances, or other specimens considered more or less representative of a language, and usually stored as an electronic database. Currently, computer corpora may store many millions of running words, whose features can be analyzed by means of tagging (the addition of identifying and classifying tags to words and other formations) and the use of concordancing programs. Corpus linguistics studies data in any such corpus ...

In the past several years, since corpus linguistics has become a very exciting subfield of linguistics. Numerous electronic corpora were created, some of the most well known ones are the followings: Brown Corpus (text samples, American English), Lancaster-Oslo-Bergen Corpus (LOB; text samples, British

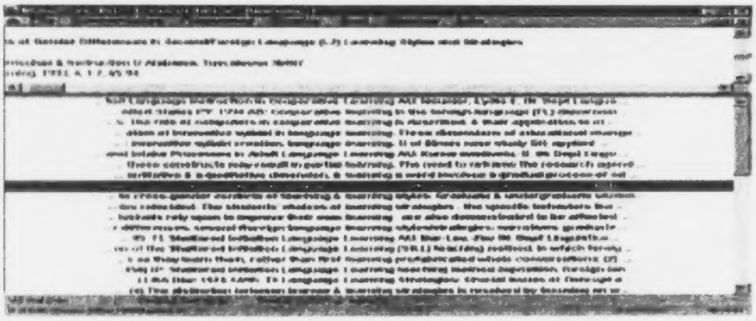
English), London-Lund Corpus (spoken British English), BNC (British National Corpus). Since a corpus often contains millions of words, corpus linguists need to use concordancing programs to uncover the patterns hidden in the huge amount of linguistic data. A concordance, in its simplest form, is an alphabetical listing of the words in a text, given together with the contexts in which they appear. The most common form of concordance today is the Keyword-in-Context (KWIC) index, in which each word is centered in a fixed-length field (e.g., 80 characters). Concordances of the word 'trust' are given below in Figure 1.

Figure 1. Concordances of the word Trust

[p] FOREIGN & Colonial Investment **Trust** has bowed to pressure from its 100,
being able to go one step further and **trust** in the love of another. [p] It took
for his friends, the House put its **trust** in him and together they faced the
all of his AIDS work. He cajoled the **Trust** into recognising its international
Status [/h] [p] T U European **Trust** is an Authorised Unit Trust Scheme
is that Sinclair, like most second **trust** lenders, doesn't want a 30-year
his grandfather was of Hitler. We **trust** many other Tory MPs will follow his
told him. I don't think he will ever **trust** me again but he had to admit he had
is a unit trust or investment **trust**-only PEP, as you can look up the trip. [p]
[p] Visit the National **Trust's** amazing Victorian folly garden at

More than a dozen of good concordancing programs are available, some well-known programs are the followings: MonoConc Pro, TACT, Word Cruncher, and WordSmith. One computer screen shot of MonoConc Pro is shown below in Figure 2. The lower window shows all the single-line concordances and the upper window shows the larger context of a certain selected concordance.

Figure 2. The Screen Shot of the MonoConc Pro Program.



The applications of corpus linguistics are numerous. According to Cathy Ball [1], these applications can be further divided into the following major domains.

1. Linguistics: to study linguistic competence or performance as revealed in naturally-occurring data. Most applications will require or lead to the creation of annotated text.
2. Diachronic linguistics: texts are all we have; introspection worthless; better to analyze a systematic collection of data than to reuse/reanalyze others' examples.
3. Computational linguistics: to train/test a natural language processing system on a representative sample of the kinds of texts the system is expected to process; to build large lexicons in a given domain ...
4. Applied linguistics: First/second language acquisition research: supplement/replace elicitation, as in 'Linguistics' above
5. Language teaching/learning: language for specific purposes (e.g. use newspaper corpora, corpora of scientific texts); to prepare vocabulary lists based on high-frequency lexical items; to prepare CLOZE tests; to answer ad hoc learner questions ('What's the difference between few and a few?'); to discover facts about language.

Geoffrey Leech [5], a prominent corpus researcher at Lancaster university, pointed out that "...while computers were limited to large mainframes available to the initiated few, computer corpora were largely restricted to research use. But as computers have grown smaller, cheaper, and massively more powerful, their use in teaching has grown immeasurably."

1.2 Data-Driven Learning and Classroom Concordancing

In recent years, the use of corpus in language teaching and language learning has grown steadily both in Europe and United States. One key approach to corpus in language teaching is the Data-Driven Learning (DDL) or Classroom Concordancing advocated by Tim Johns at Birmingham University. According to Odlin [8], Data-driven learning is an approach to language teaching that gives central importance to developing the learner's ability to "puzzle out" how the target language operates from examples of authentic usage. This approach is particularly associated with the use of computer concordances in the classroom but can be extended to other situations where the students has to work inductively from authentic data. According to Johns [3] data-driven allows language learners to explore a large amount of authentic target language texts by using the searching and indexing power of computer. This approach to second language learning is not only innovative but also powerful since it can help learners to resolve their own learning problems and help them to become independent second language learners.

Kettemann [4] and Stevens [9] suggested that there are several advantages of using data-driven learning. First, concordances give students easy and immediate access to authentic language production with many different styles and genres. Second, a concordancer is an extremely powerful hypothesis testing device on vast amount of data. It allows controlled speculation, makes hidden patterns of language use readily apparent, thus, enhances inductive thinking and exploratory leaning. Through using the concordancer on a regular basis, learners begin to develop strategies for dealing with a wide variety of texts. As a result of this kind of text analysis, learners are able to use concordance as a way of increasing their knowledge of English. Third, DDL allows students to interact with text actively and analytically and allow students to question, explore the word forms, usage, vocabulary, collocation, grammatical features, syntax, and stylistics. Learners assume control of the learning process.

2 The Underuse of Concordancing Tools

As mentioned above, the data-driven learning or classroom concordancing is such an empowering and innovative learning environment. It is an extremely useful tool for learning word usage and grammar of a foreign language. Leech [5] stated that "there is every reason to believe that language corpora will have a role of growing importance in language teaching." Researchers in different locations have been recommending it to language teachers and learners around the world. Nevertheless, classroom concordancing remains not as popular as it deserves to be. Why such a powerful learning tool and environment cannot be more popular?

John Flowerdew [2] pointed out several problems encountered when working with this new and exciting medium. First, many of the concordance lines will contain language which is beyond the proficiency level of the learners. Second, if single-line concordances are used, not all concordance lines may provide enough contexts to make the meaning clear. Third, depending on the size of the corpus and the frequency of the item chosen for concordancing, the concordancer may provide too few or too many examples of the particular usage to be illustrated. Moreover, Ma [6] also highlighted the importance of learner training. It is essential to familiarize learners with the new learning tool and environment before they can benefit from exploring the new environment.

In addition to the problems pointed out by Flowerdew, we believe that the accessibility to searching tools and corpora is another serious obstacle of making data-driven learning more popular. Both good concordancers and corpora mentioned above are not widely accessible to language learners. School or Institutes need to purchase and install good concordancing software on personal computers. Moreover, though there are many electronic texts available on the CD-ROMs and Internet, most texts are copyrighted and teachers cannot freely distribute them to second language learners. Furthermore, some hand-on training on the uses of the concordancing software is necessary since programs have rather different searching interface and functions. Even some educational institutes want to purchase the license of commercial concordancer and some electronic texts are available, students still need to go to the computer laboratory or computer center to use these precious learning resources. These difficulties and inconvenience in accessing concordancer and texts prevent second language learners from engaging in data-driven learning.

If language teachers and researchers can make a concordancing system easily and widely accessible to learners, it is more likely that second language learners will be more willing to explore the new learning environment. In the following sections, we will discuss how the Internet and web might be able to resolve some of the problems we outlined above.

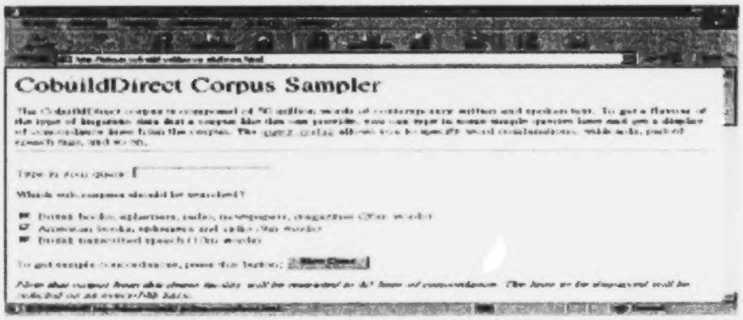
3 Web-based Concordancers

Internet and World-Wide-Web has been recommended as the most powerful platform for delivering/distributing learning materials to many learners. If a concordancing system can be made available via the Internet, second language learners can use any popular web browser to gain access to the web-based concordancing system at anytime from anywhere. They do not need to go the computer center and open the concordancer on a certain computer and load the corpus during the limited open hours.

The ideas of setting up an online concordancer loaded with text corpora have been implemented in several countries. One excellent web concordancer project is provided by Collins COBUILD project in Britain, the project generously provides a web concordancer- CobuildDirect Corpus Sampler, as an extra service for English language learners and teachers. The CobuildDirect corpus is composed of 50 million words of contemporary written and spoken text.

The interface of CobuildDirect Corpus Sampler is shown below in Figure 3. The user can type in some simple queries and get a display of concordance lines from the corpus. The query syntax allows users to specify word combinations, wildcards, part-of-speech tags, and so on. Because the corpus has been tagged automatically with a statistical tagger, we can specify a search on word/TAG combinations by appending an oblique stroke and a part-of-speech tag.

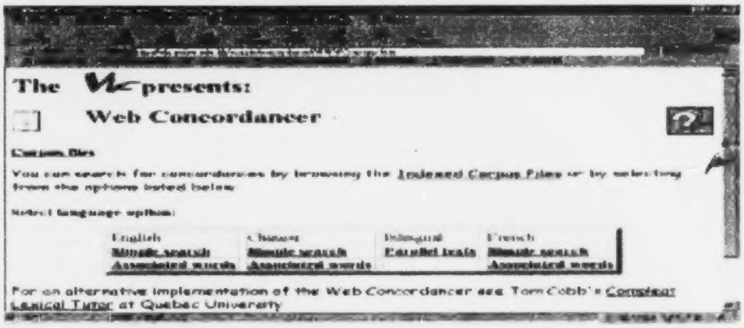
Figure 3. The Interface of CobuildDirect Corpus Sampler



CobuildDirect Corpus Sampler

Another interesting project is created and maintained by Chris Greaves and his associates at the virtual language center of Hong-Kong Polytechnic University. The interface of web concordancer is shown below in Figure 4.

Figure 4. Web Concordancer at Hong-Kong Polytechnic University



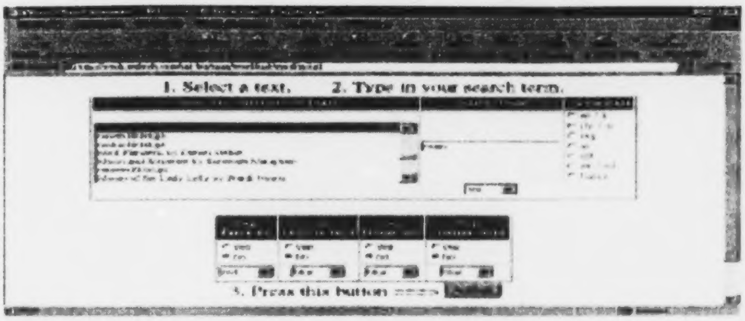
The VC presents:

Web Concordancer

For an alternative implementation of the Web Concordancer see Tom Cobb's Compleat Lexical Tutor at Quebec University

One interesting web site in the U.S. which is completely based on the Gutenburg electronic texts offers a simple Web-based concordancer, as shown in Figure 5. Although the searching options of this site are not as comprehensive as those of the other two sites mentioned above, it offers an easy-to-use web system for language learners to explore.

Figure 5. The Interface of Gutenburg Concordancer



4 The Strengths and Weakness of the Existing Web-Based Concordancing Systems

All these web sites mentioned above are useful for ESL/EFL learners. However, each of these web sites has different strengths and weakness. In the following sections, we will examine the three web concordancers more closely and compare their strengths and weakness.

4.1 CobuildDirect Corpus Sampler

CobuildDirect Corpus Sampler is one of the most powerful web concordancer. Its strengths include the wider coverage of texts (50 millions words), tagged corpora which allow learners to specify words and their specific POS (part of speech) or a certain POS tag followed by a keyword. With this powerful search option, learners can specify the words with their part-of-speech. For instance, if they want to find the usage of trust as a verb, they can simply specify the query as trust/VERB.

Its weakness for ESL/EFL learners outside of Britain includes the slow connection speed, single-line concordance output without larger contextual information, and the limited numbers of concordance output. Many students in our writing classes complain that the connection to this site via TANET (Taiwan Academic Network) is fairly slow. They often lose their patience to search the words they want to know more about because of the poor Internet connection. Besides, the system only generates single-line concordance, so the contextual information is fairly limited. The users cannot look at the larger contexts to better understand the usage of the keyword. Last, since this is a sampler, the system at most can only supply about 40 examples for a particular query; this might not be enough for words with complicated meaning and usage.

4.2 Hong-Kong Polytechnic University

Compared with the CobuildDirect Sampler, the Hong-Kong Polytechnic University web concordancer has a faster connection. In addition, it also allows learners to click on the keyword to expand a single-line concordance to view its larger context, as shown in Figure one above. As for its weakness, the connection speed to this site is still not adequate but it is faster than the speed to COBUILD site. Besides, the corpora available online at Polytechnic University are not tagged with part-of-speech tags, so the Polytechnic web concordancer does not allow for words plus POS tags search. Students indicate that they sometimes need to search a word with a particular part-of-speech so that they can locate the specific information they need more efficiently.

4.3 The Gutenburg Concordancer in the U.S.

This site is not as popular as the two sites mentioned above. All of its corpora came from the well-known Gutenburg free electronic text project, and it contains about 80 million words. Gutenburg offers the electronic texts without copyright problem. However, based on our test, this site has the slowest connection from Taiwan. Moreover, the users can only search one text file at a time, so they often cannot find the words they want to know about. All the texts are also not tagged.

The following table summarize all the strengths and weakness of these three different web concordancers.

Table 1. The Comparison of Three Different Web Concordancers

	Hong-Kong PolyTechnic Web Concordancer	COBUILD Sampler	Gutenburg Web Concordancer
Connection Speed	Moderate speed	Slower	Slowest
Larger Contexts for Keywords	Available	Not available	Not available
Tagged Texts	Not tagged	Automatic tagged	Not tagged
Text Coverage	Several million-word text files	Several large corpora about 50 million words	About 80 million words
Learner Corpora	Available	Not available	Not available

5 National Taiwan Ocean University (NTOU) Web Concordancer

With a research grant from NSC (National Science Council) of Taiwan, a research team at National Taiwan Ocean University created a web concordancer. In this project we not only try to provide a faster and more reliable concordancing system open to all interested English teachers and users but also try to overcome some weakness of currently existing web-based concordancers.

Based on the comparison of the three major web concordancers. We would like to create a web concordancer with the following features and options for Taiwanese EFL learners and teachers.
1.Fast and reliable connection and quick response.
2.Large corpora for ESL/EFL learners and teachers (including both NS corpora and NNS learner corpora).
3.Larger contexts for any searched word.
4.Tagged corpora files that allow learners/teachers to search words with POS tags.

Since we have only limited funds, we do not expect to surpass the commercial web site such as Collins COBUILD or the well-funded project of Hong-Kong Polytechnic University. We aim at creating a fast, reliable, and friendly web concordancer for Taiwanese EFL learners and teachers. We will discuss the four goals outlined above in details in the following sections.

First, the connection to NTOU web concordancer can be faster since it is built on the TANET. For TANET user, our web concordancer will be able to respond to learner's queries within 15-20 seconds. Moreover, to increase the searching speed, we reduce each corpus size to around 10-15MB. This is a technique adopted at Hong-King Polytechnic University.

Second, we expect to have large corpora. Due to the copyright restrictions, we have to rely mainly on the free electronic texts from Gutenburg projects. We are also negotiating with several local English newspapers about putting their electronic texts online for educational purpose. In addition to the native speaker corpora, we also have a smaller learner corpus available. During the past three years, we have been collecting English writing samples of Taiwanese college students. Now we have a 200,000-word EFL learner corpus, and this corpus will be a very precious resource for language teachers or researchers to better understand Chinese EFL learners' interlanguage. The interface of NTOU web concordancer is shown below in Figure 6.

Figure 6. Interface of NTOU Web Concordancer

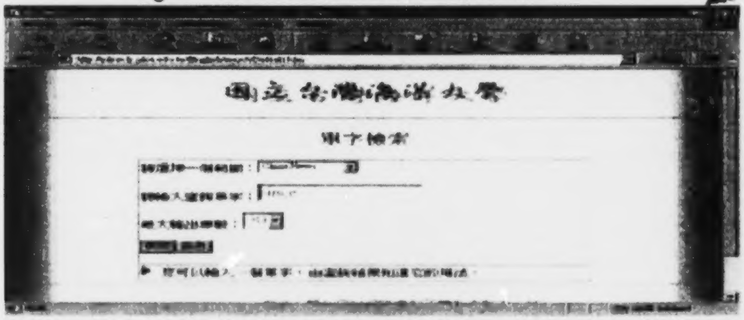
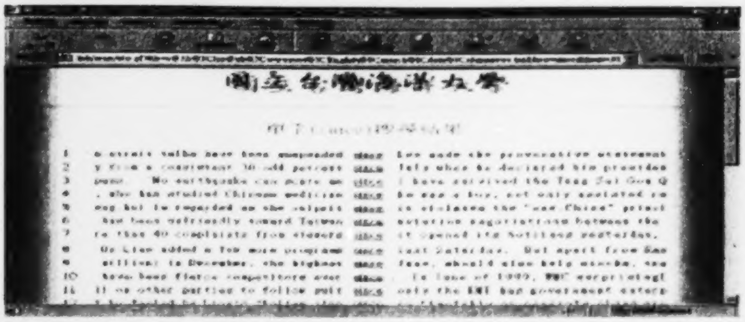
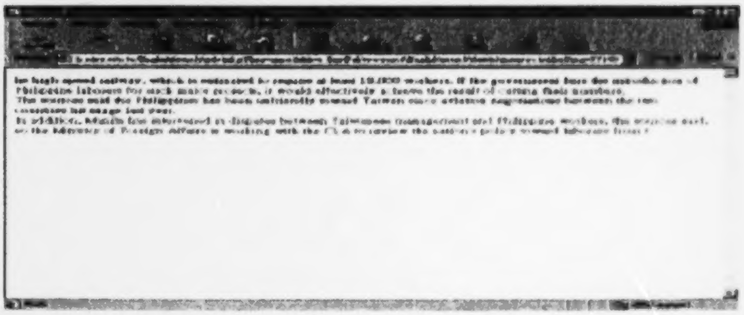


Figure 7. The Web Concordance Output



Third, since the display of larger linguistic contexts are fairly important when learners analyze the usage or the meaning of particular words or phrases. To make the data-analysis process more efficiently, NTOU web concordancer allows learners to have a convenient access to the larger context by clicking on any single-line concordance, as shown in Figure 7. An instance of the contextual information is shown below in Figure 8.

Figure 8. Larger Linguistic Context of a Concordance



Last, some learners indicated that they prefer to have the option of searching both words/phrases and POS tags when using web-based concordancers since a tagged corpus can help learners to filter out irrelevant information and help them locate the information they need more efficiently. Though the text tagging process·could be time-consuming and difficult, we have adopted some tools to create tagged corpora. The tools and techniques used in our project are described below.

5.1 Tagged Corpora

Tagging a corpus with millions of words manually is not feasible. How can COBUILD project provide such a wonderful service? In fact, they use their automatic POS taggers to carry out the POS tagging. For our project, we also purchase a useful tagger to accomplish the daunting tagging tasks.

In fact, there are quite a few taggers available. We have compared various taggers and consider the limited resources we have in hand. We decided to adopt the inexpensive automatic POS (part-of-speech) taggers, the TOSCA tagger, to annotate the corpora. The TOSCA Research Group is a team of corpus linguists at the University of Nijmegen. One focus of their research is on the development of Tools for Syntactic Corpus Analysis (TOSCA). Its tag set consists of 17 major wordclasses. With features for subclasses and additional semantic, syntactic and morphological information, the total number of different tags is 220.

It is not possible for ESL teachers or learners to use the 220 tags. So we decide to keep the system simple by converting the detailed tagging system into to the major 17 word classes so users can use these tags more easily. For instance, if one needs to know the usage of 'issue' as a verb, then he/she can input a query, issue/VB, to the system. The outcome of word plus tag search is shown below in Figure 9. The POS tags would allow users to search the corpora more efficiently.

Figure 9. Search Outcomes of Word plus Tag

be so confident. The tribunal will **issue** indictments whether or not suspects
within seven days. [p] 3.4 We can **issue** instructions to you and Cardholders
be inflationary, the Fund would only **issue** notes when they were backed by its
KITCHEN Ideas [p] Welcome to **issue** number two of 'Kitchen Ideas',
papers. 'The 13th Air Force can't **issue** orders for you to travel to
on May 16 and September 14 to **issue** passenger service requirements in
but warranted clubs are entitled to **issue** permits to members' yachts as long
The Board has no immediate plans to **issue** preference shares. However, it
A limited company that does not **issue** shares for public subscription, and
Welna: The Swiss, in fact, do plan to **issue** statements similar to the EC's
complaints is that Greece will not **issue** visas at the border as Yugoslavia

6 Conclusion

Although NTOU web concordancer has been set up and running for a short period of time, students at NTOU show positive attitude toward this new learning tool. Some students suggest that the web site should be introduced to the whole university community since they found the searching tool to be useful for English learning. It is rather encouraging to receive students' positive feedback.

However, there are still difficulties in using web concordancers. According to Sun [10], the problems of using web concordancers can be divided into two categories: one related to computing resources, another related to the difficulties of using or interpreting the concordance output. For computing resources, NTOU web concordancer still has much room for improvement. For instance, we need put in more suitable text corpora and the search speed should be faster. Besides, the automatic tagging of texts still contains some serious errors.

As for the difficulties of using or interpreting the concordance output, Ma [6] and Sun [10] pointed out that learners need training on using concordancer. For learner training, we might create an online tutorial on the use of concordancer so learners can use the system more effectively. Sun [10] also indicated that it is rather time consuming to do data analysis. Sun pointed out that the concordance output seems too large to be manageable in some cases, and learners can be overloaded with information. In fact, a corpus contains either too much or too little information would cause troubles for language learners. Flowerdew [2] points out that we need to choose our corpora more carefully and make sure the corpora will meet the needs of learners. We will continue to collect users' feedback and further improve our concordancing system.

References

[1] Ball, C., "Tutorial notes: Concordances and corpora", http://www.georgetown.edu/cball/corpora/tutorial.html, (1996).
[2] Flowerdew, J., "Concordancing in language learning", The Power of CALL, Athelstan, pp. 97-113, (1996).
[3] Johns, T., "From printout to handout: Grammar and vocabulary teaching in the context of data-driven learning", Perspectives on Pedagogical Grammar, Cambridge University Press, 293-313, (1994).
[4] Kettemann, B., "On the use of concordancing in ELT", TELL&CALL, VOL 4, pp. 4-15, (199[illegible]).
[5] Leech, G., "Corpus linguistics and language teaching", Teaching and Language Corpora: a Convergence. Longman Press, pp.1-24, (1997).
[6] Ma, K. C., "Classroom concordancing: How and what students learn", Unpublished M.A. thesis, City Polytechnic of Hong-Kong, (1993).
[7] McArthur, T. & McArthur, R. "The Oxford companion to the English language", Oxford University Press, (1992).
[8] Odlin, T., "Perspectives on pedagogical grammar", Cambridge: Cambridge University Press, (1994).
[9] Stevens, V., "Concordancing with language learners: Why? When? What?", CAELL Journal, VOL 6, No 2, pp. 2-10, (1995).
[10] Sun, Y. Z., "Web-based concordancing: challenges and opportunities for English language teaching", The proceedings of the Eighth International Symposium on English Teaching, Taipei, Taiwan, pp. 517-526, (1999).

Developing an Effective Web-Based Learning Environment for Overseas Chinese Education

Grace Chen and Kent Wang
Potomac Institute
47618 Loweland Terrace
Potomac Falls, VA 20165, USA
Grace@pidcusa.com

The world of education is in a period of rapid change. Technology in the education has recently become a primary goal of Overseas Chinese Education. Yet with all these new resources available to teachers, the opportunity for improved teaching is eclipsed by the intimidating task of finding ways to utilize computers and the Internet in a classroom environment. Overseas Chinese demographics are placing pressure on educational institutions to develop more cost-effective instructional delivery systems. In response to this pressure, education is exploring new ways of defining classrooms and utilizing distributed resources. The direction of this exploration is being guided by newly evolving technologies and information delivery systems, advances in neuropsychology and the cognitive sciences, and new philosophies and educational paradigms. The introduction of the Internet in Overseas Chinese Education has been the seminal event precipitating the emergence of one such paradigm characterized by fluidity of roles, individual learner-directed content, distributed resources, virtual facilities, and asynchronous class times. It uses technology to create learning environments with neither walls nor clocks. This paper will explore these technologies and how to develop an Effective Web-based instruction Learning Environment for Overseas Chinese Education.

Keywords: **WBI, Web-based Learning, Instruction Design, Overseas Chinese Education**

1 Introduction: The Need for WBI

As education explore new delivery systems and environments, it is necessary to observe and evaluate their effects on instructional quality and student learning. Some seek to shift the bulk of instruction to distance and distributed environments as a solution to the problems facing Overseas Chinese education today. Traditional, synchronous delivery methods utilizing physical facilities, teachers, and students have been through countless iterations and refinements. Their interactions and effects have been measured. The role of reading materials, visuals, lectures, feedback, demonstrations, and student dynamics has all been observed over many years. Before abandoning or reducing the traditional, it is necessary to ensure any modifications of existing paradigms will result in instruction that is at least as beneficial to both learners and educators as the existing one. Numerous reform movements and technical innovations have been introduced into classrooms in recent years. We have learned that these changes will not be accepted unless they are perceived to be beneficial for both teachers and students.

2 The Web Impact Instruction Design

Several things generally happen as teachers begin to use the Internet. The first occurs as teachers realize their pedagogical style needs to change if they intend to use the Internet significantly for teaching. This is typically a gradual shift but pedagogical styles do seem to change because of the robust nature of resources available and the difficulty of control over Internet usage. Some research on non-Internet network teaching activities also supports this idea. Generally, studies have found that when technology is introduced into the classroom, students experience an increase in motivation and self-esteem, accomplishment of more complex tasks, development greater technical skills and utilization of outside resources. Few studies, however, exist on the effects on student learning in distributed environments.

By combining the attributes of both Delivery of Content and System Management, and by answering in the positive the questions/issues unique to each, the instructional web-page developer will be more likely to create a strong and viable system/program that will teach, train, instruct, etc, all those whom they hope to educate via their instructional web sites. By adhering to these attributes, such a system can truly be called an Instructional System.

3 Creating good Web-based instruction

Not only does Web-based instruction need to follow good instructional design principles, but it needs to conform to good teaching practices and sound Web design principles as well. The first question educators should ask themselves before deciding to convert a course to the Web is, under the existing circumstances, is the Web itself an appropriate delivery medium.

Simply putting a course online because it is a new technology is not sufficient cause to justify the development time and cost. Another major concern is whether the online course will provide for the same level of quality teaching that a traditional class offers. Students will not accept the course if they perceive that it will be inferior.

Creating good Web-based instruction is not simply putting lecture notes online nor is it merely creating a virtual library of links to content related sites. It includes ensuring that good instructional, teaching, content, cognitive, visual, and usability design principles are followed as well as ensuring that it fulfills both teacher and student needs. Users need to perceive WBI as following objectives:

- **The Online Syllabus**
  An online syllabus provides the instructor with a way to change course material easily, and the student with a complete and up-to-date picture of the course requirements. The format need not duplicate the print version. Hypertext links to sample relevant disciplinary web sites may be helpful in giving students a sense of the disciplinary context for the course.

- **Personal Home Pages**
  Personal home pages can be used to foster the sense that the class is not just a collection of isolated individuals but a community of learners who can profit from interacting with one another. Home pages encourage students to learn about each other so as to encourage contact and mutual interests.

- **Interactivity**
  Adding discussion forums and chat sessions to your online course is a common way to add an interactive component to a web-based course. There are many implementations of bulletin board and chat session software to choose from. A second method of interactivity is, of course, e-mail. It's a good practice to have an online list of the e-mail addresses of all students.

- **Assignments**
  The web page listings of homework assignments, upcoming events and exams can be more interactive than the familiar print counterparts. If some homework assignments, for example, are based on online materials, they can be directly linked to the class schedule.

- **Announcements**
  To be effective, announcements need to be read; for that to happen, students need to know when a new announcement has been posted. Alert sounds or perhaps a blinking link added to a page can let students know of new announcements, or perhaps, even a mass e-mail to all students in the course.

- **Testing**
  Online drill or practice testing can be used to reinforce material, even if the results are not used as part of a grade. Reading comprehension questions, for example, in short answer or multiple choice

formats can provide students with an assessment of their level of understanding of text.

- **Content**
  Perhaps the most difficult part of developing a web-based course is creating the online content. You can begin by transferring your basic lecture materials to the web and integrating media such as sound, images, and video. Remember, to experiment with incorporating some of the new web-based learning paradigms described above.

4 Summary

In conclusion, developing an effective Web-based learning environment for Overseas Chinese education is not simply putting lecture notes online nor is it merely creating a virtual library of links to content related sites. It includes ensuring that good instructional, teaching, content, cognitive, visual, and usability design principles are followed as well as ensuring that it fulfills both teacher and student needs.

Developing an IT-immersion Environment to Enhance Learning and Teaching in Design and Technology

LO Ting Kau*, AU Wing Kee, and YIP Wai Ming*****
The Hong Kong Institute of Education
10 Lo Ping Road, Tai Po, N.T., Hong Kong
*E-mail: * tklo@ied.edu.hk, ** wkau@ied.edu.hk, *** wmyip@ied.edu.hk*

Design and Technology (D&T) as a school subject aims to provide learning opportunities for students to develop the technological awareness, literacy, capability and lifelong learning patterns that they need to live and work effectively in an ever changing technological society. Information Technology (IT) is quickly transforming education by breaking down the traditional boundaries of learning and teaching. This article discusses the ways that IT can be made relevant to the learning and teaching of D&T and in teacher education. It then describes the development of an ongoing project[#] which aims at developing an IT-immersion environment to enhance learning and teaching of D&T at a teacher education institution in Hong Kong. The setting up of this information-rich, collaborative learning environment is to complement "traditional" lab-based approach to learning and teaching of Computer Aided Design (CAD) and Computer Aided Manufacture (CAM).

Keywords: **IT-immersion, Learning Environment, Design and Technology, Teacher Education**

1 Introduction

Design and Technology (D&T) as a school subject "aims to provide learning opportunities for students to develop the technological awareness, literacy, capability and lifelong learning patterns that they need to live and work effectively in an ever changing technological society." [3] Information Technology (IT) is quickly transforming education by breaking down the traditional boundaries of learning and teaching. [5] IT is also being regarded as an effective tool for learning and teaching D&T in two main areas, namely:

- ***IT as a tool.*** IT can support many aspects of designing and making in D&T. For example, information processing and presentation, modelling, computer-aided design and manufacturing, control and communication.
- ***IT as a source of knowledge.*** Here, IT is being regarded as a source of knowledge to learn about materials, equipment, designing and manufacturing. This encompasses CD-ROM information systems, and the use of local or online databases accessible over the Internet. [2] [6]

2 IT in Education Policy in Hong Kong

The Hong Kong Special Administrative Region (HKSAR) Government launched its IT in Education Policy in 1998. [1] [5] According to this policy, Hong Kong teachers will be required to reach different levels of IT Competency in Education over the next few years; and IT-supported instruction will become one of the essential instructional strategies in future. Consequently, teacher education institutions in Hong Kong will be

---

[#] The project entitled "Development of an IT-immersion Environment to Enhance the Teaching and Learning of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM)" is supported by the Teaching Development Grant (TDG) administrated by the HKIEd, which is granted by the University Grants Committee (UGC), Hong Kong.

required to integrate in their pre-service programmes IT competency elements such as producing courseware, applying the skills of computer-aided instruction, and using various electronic networks for peer support and collaborative learning.

3 The Project

The following sections describes an ongoing project which aims at developing an IT-immersion environment to enhance learning and teaching in D&T at the Hong Kong Institute of Education (HKIEd), the major provider of D&T teacher education in the territory. This project is a response to the HKSAR Government's urge for the integration of IT to enhance the effectiveness of learning and teaching in teacher education institutions. [1][5] The initial target group of the project is student teachers undertaking D&T at the Institute. This target group will continually widen and might eventually include practising teachers in D&T and other technology-related subjects in Hong Kong secondary schools.

The project aims to:

- develop an IT-immersion learning environment for student teachers majoring in D&T, especially focused on areas of CAD and CAM;
- develop appropriate courseware for the enhancement of learning and teaching of basic and selected topics on CAD and CAM;
- develop an appropriate web-interface for students and staff to enhance face-to-face classroom interactions;
- enable students to appreciate modern techniques of product design and prototype making through the use of CAD and CAM technologies.

4 IT-immersion Learning Environment for D&T

Davies [4] suggests that an ideal learning environment for D&T is one where the learners have maximum autonomy and are working on self-directed projects and teachers are constantly assessing with pupils where they are and where they need to go. The IT-immersion learning environment under discussion utilises some of the attributes and resources of Web-based learning and adopts a constructivist approach to create a meaningful learning environment where learning is fostered and supported. This IT-immersion environment, we believe, would facilitates greater interaction between the teacher and students, and students and students; assist D&T student teachers transit to the new mode of learning and teaching, and enable them to develop habits of life-long learning. To effect the paradigm shift from a largely teacher-centred approach to a more interactive and learner-centred approach, it is important that D&T student teachers appreciate the need for the change and are receptive to the challenge of taking up their new role as a learning facilitator in future.

Key features of the IT-immersion environment include:

- ***Learner-centred, time and space independent learning***. With the use of Web-based instructional materials, students are allowed to progress at their own pace and at any time and space.
- ***Changing Roles of Teachers and Students***. In the IT-immersion environment, the role of the teacher changes from knowledge provider to that of facilitator and guide. Conversely, students are no longer passive learners. They become participants, collaborators in the creation of knowledge and meaning.
- ***Self-directed Learning***. One increasingly important competency in the future society will be "self-directed learning". In the IT-immersion environment, students continually learn to use IT tools for the accessing, processing, and transformation of information into new knowledge.
- ***Just-in-time Learning***. "Just-in-time learning" [7] implies a high level of individualisation and self-direction in the learning process. Each student learns just what he/she needs at the time when he/she needs it. This is a radical diversion in the instructional delivery system from place-based and time-fixed group instruction to one that is fully under learner-control.
- ***Individual differences accommodated***. Learning is a complex process that takes place as an interaction between learners and their environment. The interactive multimedia and hypermedia capabilities of Web-based and CD-ROM based instructional materials would enable student control over timing and pacing and provide interactivity and active learning.
- ***Collaborative / Cooperative Learning***. Collaborative learning in this IT-immersion environment regards that both teachers and students be active participants in the learning process. The Web, for

instance, presents an especially good environment for asynchronous collaboration in which students work together but not necessarily at the same time. This IT-rich environment also provides ground for cooperative learning that students and teachers interact together in order to accomplish a specific goal or develop an end product which is content specific. For instance, an ad-hoc group of students, teachers, and perhaps outside experts, can come together for a particular task or design project. The group splits into distributed design teams to tackle design challenges. The design teams interact over the computer network, working cooperatively and drawing on different expertise. The design is shared over the network, evaluated, and combined into an integrated artefact or system.

It is perhaps worthwhile pointing out that in an IT-immersion learning environment, IT is still considered as a supportive tool. Its introduction supplements, and indeed may change the "traditional" learning and teaching approaches in D&T. However, it is not intended to and will not replace traditional teaching altogether. For one reason, D&T is intrinsically an action-based subject. Engagement with designing and making requires students to be active cognitively and physically. Besides, lab-based activities serve a variety of different purposes that would be unlikely replaced by other means [8], for example: (a) first hand experience of using a variety of materials, equipment and processes safely; (b) actually realise high quality products, test them and evaluate them in use; and (c) face-to-face interaction among peers and the tutor.

5 Basic Components

The IT-immersion environment comprises two major components, namely: (a) the physical component, and (b) the virtual component (Figure 1).

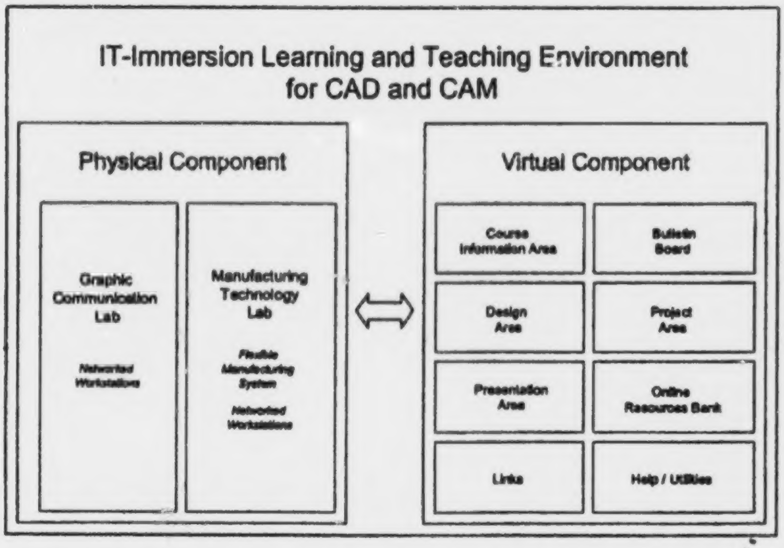

IT-Immersion Learning and Teaching Environment for CAD and CAM
Physical Component
Graphic Communication Lab
Networked Workstations
Manufacturing Technology Lab
Flexible Manufacturing System
Networked Workstations
Virtual Component
Course Information Area
Bulletin Board
Design Area
Project Area
Presentation Area
Online Resources Bank
Links
Help / Utilities

Figure 1. Major Components in the IT-immersion Learning and Teaching Environment.

The ***Physical Component*** includes facilities installed in the two labs at the HKIEd for CAD and CAM:

- ***Manufacturing Technology Lab***: A Flexible Manufacturing System (CNC Lathe, CNC Mill, and Robot), a CNC micro-router, 15 networked PC workstations, video-conferencing systems, appropriate software and peripherals, etc.
- ***Graphic Communication Lab***: 21 networked PC workstations, video-conferencing systems, digital camera, appropriate software and peripherals, etc.

The ***Virtual Component*** of the IT-immersion environment include:

- ***Course Information Area*** - for students to gain access to course-specific information such as course outlines, schedules, course materials, assignments and other course-related information.
- ***Bulletin Board*** - for teachers and students to post up announcements.
- ***Design Area*** - for supporting both synchronous communication (e.g. real-time interactive chat, used to brainstorm with teachers or peers) and asynchronous communication (e.g. e-mails) to facilitate design activities. For example, students can "talk" online and discuss their design ideas via video-conferencing and/or Internet technologies with peers, teachers or experts outside the campus who can provide them with suggestion for improvement on the design. Digital cameras can be used to record the development of models/products and to present design ideas.
- ***Project Area*** that houses students' individual and collaborative design projects. A Data Bank will be set up for students to store their design works. The Data Bank will become a central design database, accessible by all members of each of the design and manufacturing teams to ensure that all team members are working with identical information.
- ***Presentation Area*** - for students to present their projects and showcase their design work beyond the classroom and to a wider audience.
- ***Online Resource Bank*** - for teachers to upload and retrieve interactive instructional and reference materials.
- ***Internet links*** - to support teachers and students using the Internet to locate professional materials and content resources in D&T and other related disciplines.
- ***Help / Utilities.***

6 IT-enhanced Activities and Learning Experiences

In the IT-immersion environment, student teachers are provided with the opportunities to use IT to explore, develop, model, communicate and realise their design ideas in a variety of ways. As such, IT becomes an integrated and natural part of their study in D&T. More specifically, to take as an example, video conferencing technology can be used as an effective medium for developing new ways of learning and teaching D&T and introducing teachers and students to various aspects of information, communications and design technologies. Using the latest information and communications technology provides the opportunity for expertise and resources to be made available to pre-service and practising D&T teachers off-campus from the HKIEd. Via video conferencing systems or the Internet, they can work collaboratively together on concurrent design projects, discuss problems and jointly solve them, and exchange ideas and information.

In brief, working in an IT-immersion environment would help D&T student teachers to understand how to become discerning users of available hardware and software. This in turn, would help them to understand what IT can and will do to enhance their future pupils' learning in D&T.

7 Conclusion

This paper discussed the potential of an IT-immersion approach to provide D&T student teachers with a richer, more meaningful education relevant for the future workplace and learning environments. It is also suggested that this IT-immersion approach can be used in a mixed-mode manner to support traditional lab-based approach to learning and teaching CAD and CAM. This adjunct or mixed-mode seems appropriate for a wide range of learning and teaching activities in D&T where real world experience and face-to-face interaction are essential. By using a mixture of traditional and IT-immersion instructional methods and tools, the learner can experience recent technology development and its impacts on learning. The point is to find out the right balance.

The project is still at its developmental stage, the effectiveness of the IT-immersion approach to learning and teaching D&T has yet to stand the test of time. However, the experience so far suggests that the project will be a success and will bring substantial benefits to both teaching staff and students.

References

[5] Au, W. K., Kong, S. C., Leung, K. P., Ng, M.W. & Pun, S. W., "Level of Information Technology Competency, Core Course Elements and Assessment Tool for Teacher Training in IT in Education: The Final Report", Hong Kong: Education Department, HKSAR, (1999).

[4] Barlow, J., "Computers in Technology Education", in J. Williams & A. Williams (Eds.), "Technology Education for Teachers", pp. 136-179, South Melbourne: Macmillan Education Australia, (1996).

[1] Curriculum Development Council (CDC), "Syllabus for Secondary Schools: Design & Technology (Secondary 1-3)", Hong Kong: CDC, (1999).

[6] Davies, L., "Virtually There! The Millennium", The Journal of Design and Technology Education, Vol. 4, No.1, pp. 61-64, (1999).

[2] Education and Manpower Bureau (EMB), "Information Technology for Learning in a New Era: Five-Year Strategy 1998/99 to 2002/03", Hong Kong: Education and Manpower Bureau, (1998).

[3] National Association of Advisers & Inspectors in Design and Technology (NAAIDT), "Enhancing Design and Technology through the Use of IT", Wellesbourne: The Design and Technology Association (DATA), (1995).

[7] Romiszowski, A., "Web-Based Distance Learning and Teaching: Revolutionary Invention or Reaction to Necessity? ", in B. Khan. (Ed.), Web-based instruction, pp. 25-37, Englewood Cliffs, NJ: Educational Technology Publications, (1997).

[8] Wankat, P. & Oreovicz, F., "Teaching Engineering", New York: McGraw-Hill, (1993).

Developing Web Courses Systematically

Ming-Chou Liu
National Hualien Teachers College, Taiwan
123, Hua-Hsi Rd., Hualien, Taiwan 970
Tel: +886-3-8226724
Fax: +886-8-234225
E-mail: liu@sparc2.nhltc.edu.tw

This article first examines the development needs of web-courses from a panoramic viewpoint, contemplating what is required in terms of content, user-interface and pedagogy, or CUP in short. Then the process of web-course development is studied as a system and the various stages in the process are explored. Finally graphs and tables as management tools are designed to enable the effective development of web-courses.

Keywords: **web-course, learning theories**

1 The significance of web-course

Generally speaking, the advantages of learning in the World Wide Web environment include breaking the barrier of time and space, learning without walls, and just-in-time learning [4]. The effect of learning on the Web can be analyzed with 3Ws(What, How, Why). In addition to the "know-what" of conceptual knowledge and the "know-how" of procedural knowledge, there is also the "know-why" of collaborative learning brought about by communication on network. Obviously, whether a web-course can achieve its intended effect is under the influence of the three major factors stated above. 1) Content, the proper choice of materials to be used and good design is the first step to successful learning with a web page. 2) User-interface: now that we have the teaching material as the content of the page, what about presenting the materials? That is another major issue of concern. For example, studies by Nielson(1998) and others indicate that the way many web users read web pages is scanning the pages in its entirety. Therefore, it is important to grasp the learner' s attention with neatly designed web pages in which all the data are effectively organized. That leads to the learner' s perception and learning of the information on the pages. Complying with the learner' s cognitive process is an important issue to be considered in the design of user-interface. This definitely involves the design and arrangement of learning activities and environmental influences. 3) Pedagogical foundations: we' ve seen the what-to and the how-to of the way things are done, but we can' t help asking why they are done this way. Creed & Plank(1998) maintain that "good web site design begins with good pedagogy." Also, Duchastel & Turcotte(1996) think that instruction design in an information-rich environment must deviate greatly from that in the traditional learning environment. For a web-course to be effective, the theoretical foundation of relevant pedagogy is indispensable; and cognitive psychology is the most important among the relevant theories.

2 Developing web-courses

From the perspective of software engineering, there are procedures and stages in the development of web-courses. Like designing traditional computer-assisted instruction (CAI) programs, various procedures and stages are involved, from choosing the subject, designing teaching materials and methods, writing the story board, to programming, testing and finishing the product. The most significant difference between web-courses and traditional CAI programs is that the former can be built incrementally; that is, new content can be added into the course at any time. In contrast, the latter is more fixed and closed in nature, usually with no possibility to make modification of addition to the content before upgrading the program to a new version. Many scholars come up with their own theories of how many stages there are in the development of web-courses [3][4], but generally their ideas are based on the structure shown in Fig.1.

The first stage spans from the conception of idea to feasibility study. If the factors of technicality, obtaining of content and effectiveness are all under control, and if the budget allows, then the developer can proceed to the second stage of detailed planning. Table 1 can serve as an excellent tool for assisting the planning in this stage.

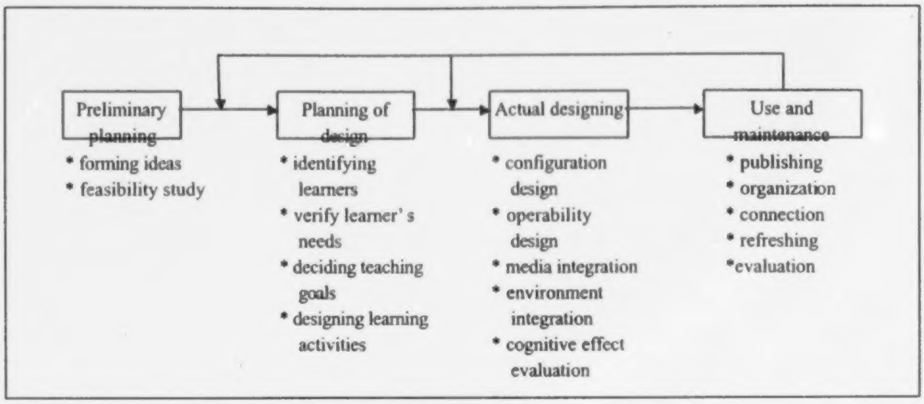

Preliminary planning
* forming ideas
* feasibility study
Planning of design
* identifying learners
* verify learner' s needs
* deciding teaching goals
* designing learning activities
Actual designing
* configuration design
* operability design
* media integration
* environment integration
* cognitive effect evaluation
Use and maintenance
* publishing
* organization
* connection
* refreshing
*evaluation

Fig.1 Stages in the development of web-courses

If the level of difficulty in the chart falls on the right side of the dotted line, then there may be practical difficulties in implementing the project. Although that does not necessarily mean the project is "dead on arrival," it surely means that further analysis and more contemplation is required. Take the planning of human resources for example: individual tasks can be put into a two-dimensional chart together with human resources for analysis, which brings about further understanding of the demand for manpower in the project and helps identifying the source that potential workforce comes from. The use of this kind of chart can also be extended to the analysis of demand for workforce in other stages (stage x manpower) and other aspects. Table 2 is an example to help the analysis of tasks and demand for manpower.

Table 1 Feasibility analysis chart for web page planning

Subject of the web page:						
Targeted users:						
Features of function:	1. 2. 3.					
Possible difficulties		**Level of difficulty**				
		None	Supposedly none	Unsure	Possibly insurmountable	Insurmountable
Technicality	1. Media production	• •	• •	• •	• •	• •
	2. Media integration	• •	• •	• •	• •	• •
	3. Interactive skills	• •	• •	• •	• •	• •
	4. programming	• •	• •	• •	• •	• •
	5. Database processing	• •	• •	• •	• •	• •
Content	1. Subject a	• •	• •	• •	• •	• •
	2. Subject b	• •	• •	• •	• •	• •
Management	1. Human resources	• •	• •	• •	• •	• •
	2. Time restraint	• •	• •	• •	• •	• •
	3. Budget restraint	• •	• •	• •	• •	• •
Projected benefits (effect on learning results)		• • high	• • medium-high	• • medium	• • medium-low	• • low

Table 2 Chart for analysis of tasks and demand for manpower

Task / Manpower	A.	B.	C.	D.	E.	F.	G.	H.

A. Choice of material
B. Planning of material
C. Media production
D. Media integration
E. Web page design

1. Domain expert	• •	• •			• •			
2. Teaching expert	• •	• •			• •			
3. Testing expert	• •	• •						
4. Media expert	• •	• •	• •	• •	• •			
5. Programming expert	• •	• •	• •	• •	• •	• •	• •	
6. Artwork expert			• •	• •	• •			
7. Story-board expert		• •			• •			
8. Management expert	• •	• •	• •	• •	• •	• •	• •	• •

Legend: • : demand of high urgency • : demand of medium urgency• : demand in low urgency

It is more difficult to be educational with the commonly used design of web pages in general, and the ideas of education experts should be consulted. An evaluation chart as Table 3 adapted from Reeves & Reeves(1997) is very useful as a reference.

Table 3 An evaluation chart for the educational merits of a web-course

Quality	Distribution		
1. Pedagogical philosophy	Instructivist	• • • • • • • • • • •	Constructivist
2. Learning theory	Behavior	• • • • • • • • • • •	Cognitive
3. Goal orientation	Focused	• • • • • • • • • • •	General
4. Tasks orientation	Academic	• • • • • • • • • • •	Authentic
5. Source of motivation	Extrinsic	• • • • • • • • • • •	Intrinsic
6. Teachers role	Didactic	• • • • • • • • • • •	Facilitative
7. Meta-cognition	Unsupported	• • • • • • • • • • •	Integrated
8. Collaborative learning	Unsupported	• • • • • • • • • • •	Integrated
9. Cultural sensibility	Insensitive	• • • • • • • • • • •	Respectful
10. Structural flexibility	Fixed	• • • • • • • • • • •	Open

From a wider perspective, it is not advisable to limit web-courses to a fixed kind of teaching method. The nature different subjects of instruction should be considered, and a suitable corresponding teaching method should be adopted.

Although there can be many teaching methods, their intended goal is one: the optimum learning results. There is paradigm shifting in instruction design, and the resulting new trend emphasizes that the design must be learner-centered. This is learning environment development based on constructivism. Problem-based learning is a design principle pretty much in keeping with this new trend. Simply stated, the way it works is to lead learners to think and solve problems using embedded questions, therefore achieving learning results.

In the actual construction stage, the main issues for web-courses are the design and integration of content, and the user-friendliness. These are the factors that ensure the smooth delivery of the instructional content and unfettered proceedings of learning activities. When web-course development comes to the "use and maintenance" stage, the well-constructed content is published to the Internet, the IP addresses organized and managed, and all links made sure to work. The content should be updated as frequently as possible to keep it up-to-date, making the pages alive and fresh. Moreover, evaluation can be made to see whether the web-course has achieved its goals as planned, and whether the content conforms to the CUP standards. The evaluation can be formative, with the focus on whether systematic methods are used to facilitate the effectiveness of development. Or it can be summative, with the content, educational merits, user-interface, measurement design, and course design and management being examined. The content refers to the richness, organization and level of difficulty of the materials for learning. Educational merits refers to the presence of an educational objective, whether effective instruction methods are employed, etc. User-interface means whether there are well-designed page layout, well-organized components, tools provided to users to ensure easy capture of teaching material and effective learning. Measurement design refers to the presence of interaction and tests, and the validity and effectiveness of the tests. Finally, course management focuses on the effective operation of the system to facilitate smooth progress of learning and maintaining the coherence of all data on the web site. Based on the indicators discussed above, we can develop an evaluation chart as in Table 4. Each item is rated in A(high), B(medium) or C(low), and the number of times A, B and C appear are calculated. This provides system developers timely control on the construction and content of the web-course.

Table 4 Web-course evaluation chart

Topic	Item	Effect	Note
Content	1. A clear learning subject	• A • B • C	
	2. Good analysis of users	• A • B • C	
	3. Suitability of teaching method	• A • B • C	
	4. Richness of teaching materials	• A • B • C	
	5. Organization of teaching material	• A • B • C	
	6. Difficulty level of materials	• A • B • C	
	subtotal: ____A ____B ____C		
User-interface	1. Smoothness of operation	• A • B • C	
	2. Organization of web page	• A • B • C	
	3. Availability of learning tools	• A • B • C	
	4. Interactive design	• A • B • C	
	5. Measurement design	• A • B • C	
	6. Multimedia effects	• A • B • C	
	subtotal: ____A ____B ____C		
Pedagogy	1. Instructional goal	• A • B • C	
	2. Instructional method	• A • B • C	
	3. Course management	• A • B • C	
	4. Motivational design	• A • B • C	
	5. Evaluation of learning results	• A • B • C	
	subtotal: ____A ____B ____C		
Total: ____A ____B ____C			

3 Conclusion

The development of web courses takes time and good planning ahead. Thorough consideration about the content and teaching methods can result in effective learning. It is important not to be overwhelmed by the colorful effects of multimedia to the extent that the emphasis on content is compromised. We have proposed C, U and P as three dimensions that serve as directions along which ideas about web-course design can be developed. A few charts are developed as tools that can help systematically developing web-courses. This will supposedly make the web-course development process more manageable, and the instructional effects of web-courses more worth our wait.

Reference

[1] Creed, T. & Plank, K., "Seven principles for good course Web Site design.", The National Teaching and Learning Forum, 7(3), 8-10.,• 1998• •

[2] Duchatel, P. & Turcotte, S., "On-line learning and teaching in an information-rich context", Proceedings of the 1996 Internet Conference of the Internet, Montreal. (1996)

[3] Hackbarth, S., "The educational technology handbook: A comprehensive guide–Process and products of learning.", Englewood Cliffs, NJ: Educational Technology Pubs. (1996)

[4] Nichols, G. W., "Formative evaluation of Web-based instruction". In B. H. Khan (ed.). Web-based instruction. 369-374. Englewood Cliffs, NJ: Educational Technology Pubs. (1997)

[5] Nielsen, J., "Designing Web site with authority: Secrets of an information architect.", Indianapolis: New Riders Pubs. (1998).

[6] Reeves, T.C. & Reeves, P. M., "Effective dimensions of interactive learning on the World Wide Web.", In B. H. Khan (Eds.). Web-based instruction. 59-66. Englewood Cliffs, NJ: Educational Technology Pubs.(1997).

Developing Web-Based Language Learning Environment

Yun Du
Second Language Teaching and Curriculum Center
Moore Hall 255, East-West Road
Honolulu, Hawaii 96822
Tel: (808) 956-5130
E-mail: ydu@hawaii.edu

The World Wide Web is becoming a popular media to conduct distance learning. However, using the Web for distance language learning is still a challenge. This paper introduces a Web-based language learning environment which is used to deliver upper-level second language courses. The three major design considerations (instructional design, interaction design and knowledge-building capability design) are discussed. The functions and major features of the learning environment are also described.

Keywords: **Web-based learning environment, computer-assisted language learning**

1 Introduction

Today's distance learning no longer assumes that knowledge is static and education is a certain years' procedure. Instead, knowledge is changing and evolving, so that education is a life long process. Education should be able to meet people's needs, no matter how old they are, where they are, or what jobs or positions they hold. The World Wide Web, with its worldwide access and friendly interface, becomes the desired media for conducting distance learning today. Compared with traditional classroom teaching, Web-based learning offers new opportunities:

- It extends the boundaries of learning so that learning can occur at any time, in any place. As a result, learners have more flexibility of choosing the way to learn.
- It emphasizes on collaboration and interaction that can be effectively employed toward learning. Using the Web, learners can not only communicate with the instructors or classmates, but also can go beyond the classroom to collaborate with people from other schools, institutions, organizations, and to ask questions to professionals and experts.
- Various resources of information on the Web extend the content of the instruction. Students are able to access multimedia information on almost every subject and in multiple languages.
- Web-based instruction offers opportunities for more creative activities. Students can search information on the Web, create their own resource repository, meet virtually with classmates and instructors, and do a lot more.

In this paper, a Web-based learning environment for language learning will be introduced. This learning environment is used for delivering instructional resources in Chinese at the 3rd/4th-year level and in Korean at the 2nd/3rd-year level to learners nationwide via the Web. The first Web-based class using the learning environment, CHN399 *Chinese Reading and Writing Course,* was officially offered to the students at University of Hawaii in the spring semester, year 2000. The last two units of the course also involved students from Taiwan to collaborate with students at UH. The course is a success. Twelve students have completed the course. In the fall semester, in addition to this course, a *Chinese Listening and Writing Course* and a *Korean Reading and Writing Course* will also be offered, using the same learning environment.

2 Major Design Considerations

The design of the Web-based language learning environment has been focused on three parts: instructional design, interaction design and knowledge-building capability design.

2.1 Instructional Design

Instructional design addresses the pedagogical issue of language learning. It determines the goal and format of the course, the instruction approach, the activities involved and the evaluation criteria. For this learning environment, we adopt an instructional model that contains the following five stages:

- Stage 1 Pre-activities: aim at activating students' prior knowledge, and helping them predict the content of the text
- Stage 2 Global activities: emphasize on helping students master the content and the main points of the text
- Stage 3 Specific information activities: use various language-centered tasks to train students to memorize the main points of the text while reading
- Stage 4 Linguistic activities: allow student to use the new knowledge after the they have mastered the content and main points of the text
- Stage 5 Post activities: integrate what have been learned from the previous four stages and help students accomplish a language task that involves using the new words, concepts and knowledge

Based on these stages, a series of activities have been designed. Students are evaluated mainly by the quality of their writings, and also by the quiz conducted at the end of each unit.

2.2 Interaction Design

Communication is very important for language learning. Communicative language learning theory emphasizes on interaction between learner and instructor as well as between learner and learner. Underwood [3] proposed a series of "premises for communicative CALL" (CALL refers to Computer-Assisted Language Learning), including "focuses more on using forms than on the forms themselves", "Teaches grammar implicitly rather than explicitly", "allows and encourages students to generate original utterances rather than just manipulate prefabricated language", etc. Interaction has been carefully designed to embed these principles into the learning environment. Different Web-based forums were developed for different learning purposes: asking questions about the text, practicing language through task-based group discussion, diagnosing grammar mistakes and writing essays on a specific subject. The asynchronous communication mode provides the following advantages:

- Students can have more flexible schedule; they can access the class at any time.
- Students have more time composing messages, and can modify messages even after they have been submitted. This is good for language learners who not only concern the content of the message but also the form of the language.
- Students can save specific messages for future reference.
- Students can search and retrieve specific messages afterwards.

2.3 Knowledge-building capability design

There are three major aspects of current learning theories. First, learning is a process of knowledge construction, not of knowledge recording or absorption. Effective learning depends on the intentions, self-monitoring, elaboration and representational constructions of the individual learner [2]. Second, learning is knowledge-dependent, and knowledge-driven [1]. People use current knowledge to construct new knowledge. Third, learning is highly tuned to the situation in which it takes place. Knowledge is not independent of the contexts (mental, physical, and social) in which it is used [2]. These theories indicate the importance of supporting knowledge building in a learning environment so that students can acquire, record, share, and integrate knowledge.

In our Web-based language learning environment, in addition to allowing students to discuss and share ideas in the forums, based on the characteristics of language learning, the knowledge building also includes following processes:

- Store resources related to the subject
- Build word vocabulary
- Compile grammar rules
- Collect and comment on writing examples, commonly used phrases and idioms, etc.

3 Major features of the Web-based language learning environment

The components of the final system are shown in Figure 1.

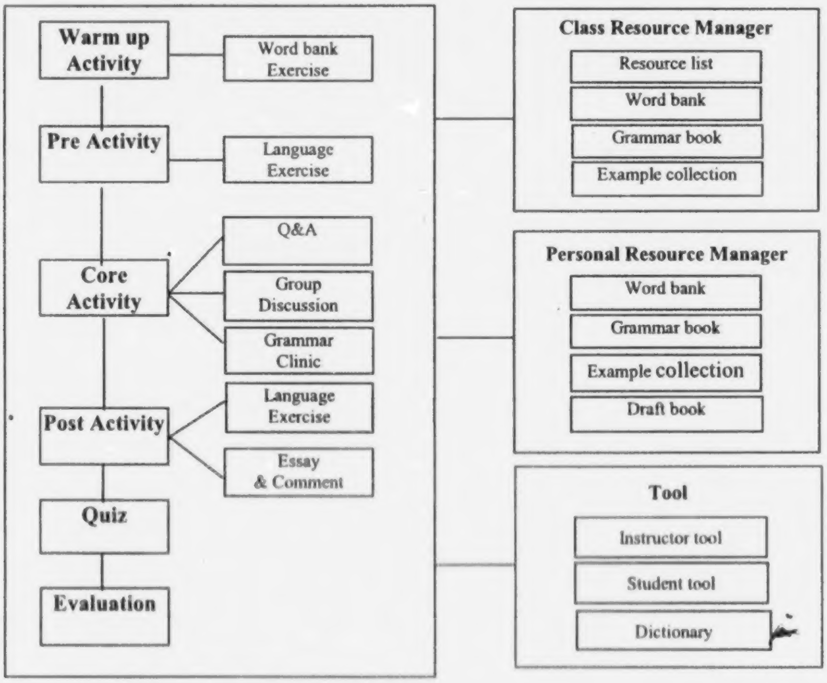

Warm up Activity
Word bank Exercise
Pre Activity
Language Exercise
Core Activity
Q&A
Group Discussion
Grammar Clinic
Post Activity
Language Exercise
Essay & Comment
Quiz
Evaluation
Class Resource Manager
Resource list
Word bank
Grammar book
Example collection
Personal Resource Manager
Word bank
Grammar book
Example collection
Draft book
Tool
Instructor tool
Student tool
Dictionary

Figure 1. Components of the Web-based language learning environment

3.1 Language teaching/learning support

The system supports language teaching based on a specific instructional model that sequences the learning process into several stages. The goals, processes, activities and tasks are well integrated into the functions of the system. Different rights and privileges are assigned to instructors and students to ensure that the teaching and learning procedure is followed. Using the system, the students are able to do language exercises, share information, ask questions, participate in task-based group activities, write essays, comment on fellow students' writing, build vocabulary, summarize grammar points, and so on, while the instructors are able to teach reading and writing skills, answer students' questions, correct grammar mistakes and evaluate students' progress.

Based on the instructional model, the learning process is sequenced into the following activities:

- Warm up activity: involves students' building word vocabulary (called *word bank*). This activity corresponds to the first stage of the instructional model: pre-activity that aims at activating students' prior knowledge about the topic.

- Pre-activity: involves doing language exercise such as matching words. This activity is also part of the first stage of the instructional model.

- Core activity: contains three parts. The first part involves students reading text (that is stored on CD-ROM), doing reading comprehension exercises and asking questions. This part corresponds to the second stage: global activities, and the third stage: specific information activities. The second part of the core activity is for students to participate in small group discussion to accomplish a given task, e.g. decide where to eat dinner. In the third part, instructors select mistakes from students' messages and post them in a forum called grammar clinic, and the students are asked to correct these mistakes. These two parts are designed to fulfill the goals of stage four: linguistic activities.

- Post activity: requires students to write an essay on the given topic. This activity is designed to integrate the knowledge they have learned, which corresponds to the fifth stage of the instructional model.

In addition to these activities, each unit of the class also has quiz, aiming at evaluating students' mastery of the material through quantitative criteria.

3.2 Database support

The system is developed using database technology. The database system is implemented on Microsoft SQL server. Basically the database system collects the data generated by the activities involved in the class.

- Stores the information of students and instructors
- Supports word bank
- Supports forums for class interaction
- Supports class and personal resource manager
- Supports quiz and grading
- Supports collecting survey data
- Collects data for administration such as login records

3.3 Asynchronous interaction

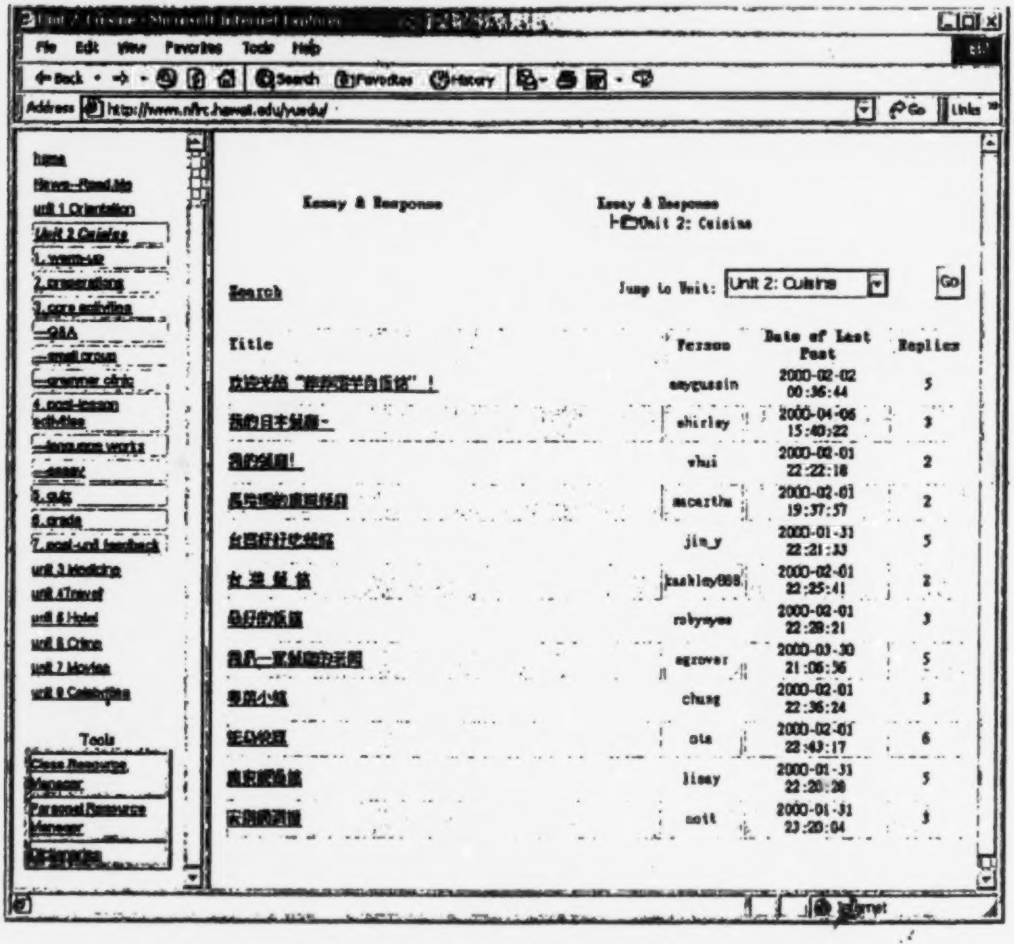
Web-based forums support the interaction among users. The asynchronous forums allow students to do the following things:

- To participate in the activity at any time
- To edit a message even after it has been submitted
- To save a specific message for future reference or as a knowledge item
- To search and to retrieve messages

The class interaction is supported by five forums:

- ***Class news forum***
  This forum is for instructor and students to exchange information including class announcement, cultural trivia, etc. Both instructors and students can post threads as well as replies.

- ***Essay forum***
  This forum is for students to post their essays and comment on essays written by fellow students. Both instructors and students can post threads as well as replies. (See Figure 2.)


Unit 2: Cuisine - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://www.nflrc.hawaii.edu/yuedu/
Go Links
home
News—Read Me
unit 1 Orientation
Unit 2 Cuisine
1. warm-up
2. preparations
3. core activities
—Q&A
—small group
—grammar clinic
4. post-lesson activities
—language works
—essay
5. quiz
6. grade
7. post-unit feedback
unit 3 Medicine
unit 4 Travel
unit 5 Hotel
unit 6 Crime
unit 7 Movies
unit 8 Celebrities
Tools
Class Resource Manager
Personal Resource Manager
Dictionaries
Internet

Essay & Response

Essay & Response
Unit 2: Cuisine

Search

Jump to Unit: Unit 2: Cuisine Go

Title	Person	Date of Last Post	Replies
[illegible]	amygussin	2000-02-02 00:36:44	5
[illegible]	shirley	2000-04-06 15:40:22	3
[illegible]	vhui	2000-02-01 22:22:18	2
[illegible]	macartha	2000-02-01 19:37:57	2
[illegible]	jin_y	2000-01-31 22:21:33	5
[illegible]	kashley888	2000-02-01 22:25:41	2
[illegible]	robynyms	2000-02-01 22:28:21	3
[illegible]	egrover	2000-03-30 21:06:36	5
[illegible]	chung	2000-02-01 22:36:24	3
[illegible]	ota	2000-02-01 22:43:17	6
[illegible]	lissy	2000-01-31 22:20:20	5
[illegible]	soit	2000-01-31 23:20:04	3

Figure 2. Essay forum in the Web-based language learning environment

- ***Q&A forum***
  This forum is for students to post questions regarding the content of the text as well as the usage of the CD-ROM. Both instructors and students can post threads as well as replies.

- ***Small group discussion forum***
  This forum is for students to participate in task-based group discussion. Students will be directed into their group when they enter the forum and they can post messages there. They can go to see other groups' interaction, but they cannot post any messages in other groups' discussion area.

- ***Grammar clinic forum***
  Instructors select grammar mistakes from the students' posts, put them in this forum, and ask students to correct them. Only instructors can post threads, students can only post replies.

Designing individual forum for each activity or task makes it possible for forums to serve different purposes and to have different controls over students' privilege of posting messages. For example, in grammar clinic forum, only instructors can post threads (students can only post replies), but in class news forum, everybody can post threads. In all the forums, the instructors reserve the rights to delete messages.

3.4 Knowledge building

The system provides knowledge-building capability that allows users to gather information, discuss ideas with others as well as generating, storing and retrieving knowledge. The knowledge building process is facilitated using two tools: class resource manager and personal resource manager. Both the resource managers include resource list, word bank, grammar book, and example collection. In order to support knowledge building at both collective level and individual level, the knowledge- building tool has two types: one for the whole class (class resource manager), and one for the individual student (personal resource manager). Class resource manager can be accessed by the whole class, while personal resource manager is individualized and can only be accessed by student himself or herself. The personal resource manager also includes a draft book for the student to store his or her writing drafts. The instructors have most of the control over class level knowledge-building tool, but the students have full control over their own knowledge-building tools. The knowledge-building functions provided include:

- Allows knowledge-building at both class level and individual level
- Allows users to collect information resources (Web sites, article, etc.) into *resource list*
- Allows users to collect words into *word bank*
- Allows users to collect or compile grammar rules into *grammar book*
- Allows users to collect writing examples or idioms into *example collection*
- Allows users to save messages from discussion forums to the resource managers
- Allows users to write note or comment on resource or knowledge items

Currently, the grammar book and the example collection in class resource manager are controlled by the instructors, meaning that instructors summarize grammar points and select examples and put them in the class resource manager. Students can read them but they cannot put their own notes there.

3.5 Online quiz

Students can take quizzes online. The quiz contains multiple choices and is graded automatically so students can get their grade immediately after they submit the answer. Instructors can check students' quiz grades along with the information such as how long the students complete the quiz and their answers to each question.

3.6 Tracking capability

The tracking system built for this learning system record student's clicks into the database while they are navigating the class. The information recorded include the location of the student, the action the student makes, the time of the action and other relevant data such as the message the student is reading. The tracking system offers the following benefits:

- The tracking system can provide valuable information for system developer. Users use a system in different ways. Therefore, how users navigate our the learning system, how they use the interface and how they use the various functions become interesting questions whose answers will help the system developer understand the operation of the system so that the system can be improved to better meet users' needs.

- The tracking system also provides valuable information for the instructors. It tells the instructor how students do self-learning in the distant environment, how they follow the process designed for the course, how they participate in the activities, how they approach a task, how they respond to a teaching strategy, and so on. The information will help the instructors understand students' behavior (e.g. learning strategy) and adjust their teaching methods to make the course more effective.

3.7 Monitoring and evaluating performance

The system provides ways for the instructors to conduct teaching as well as monitoring and evaluating students' performance:

- Monitor students' participations according to their login records, frequency and length of their posts, and so forth
- Evaluate students' performance according to their participations, contents and form of their writings, and so forth
- Give grades and feedbacks to students
- Understand students' learning behavior by analyzing tracking records

4 Conclusions

Observations from the Web-based Chinese reading course show that this Web-based language learning environment successfully support the class operation. Students and instructors are able to choose their own time, place and pace to work on the course. And, they have been engaged in active interactions during the course. The functions provided by the learning environment meet the instructional goals and requirements.

References:

[1] Glaser, R., "Education and thinking: The role of knowledge", American Psychologist, Vol 39, pp. 93-104, (1984).
[2] Resnick, L. B., "*Knowing, learning and instruction*", Hillsdale, NJ: Lawrence Erlbaum Associates, (1989).
[3] Underwood, J., "Linguistic, computers, and the language teacher", Rowley, MA: Newbury House, (1984).

Development and Evaluation of a CALL System for Supporting the Writing of Technical Japanese Texts on the WWW

Jie Chi Yang* and Kanji Akahori**
**National Central University,*
38, Wu-Chuan Li, Chung-Li, Tao-Yuan, Taiwan 320
E-mail: yang@src.ncu.edu.tw
***Tokyo Institute of Technology*
2-12-1 O-okayama, Meguro-ku, Tokyo 152-8552, Japan
E-mail: akahori@cradle.titech.ac.jp

This paper describes the development and evaluation of a Computer Assisted Language Learning (CALL) system for supporting the writing of technical Japanese texts on the WWW. To analyze discourse structure of technical Japanese texts, cohesive expressions are used as cue words. The rules for analyzing texts are based on micro-level and macro-level information, namely cohesive expressions and headlines. A CALL system for helping foreigners to learn to write technical Japanese texts is developed using Natural Language Processing (NLP) techniques. The main functions of the system are: automatically detecting headlines and cohesive expressions in technical Japanese texts, displaying this information on the WWW, and extracting examples from the corpus of technical Japanese texts. The results of a system evaluation show that the system obtained a high degree of accuracy on extraction of cohesive expressions and headlines by using the revised rules set proposed in this study. Furthermore, two evaluation experiments are conducted to examine the effectiveness of the system. The system is evaluated in terms of subjects' intuitive impression and actual usage of the system in the two experiments, respectively. The results of the study show that the instructive effectiveness of the system. The result of the interview also shows that the system is not only suitable for technical Japanese writing but also for Japanese language learning.

Keywords: **Computer Assisted Language Learning, Natural Language Processing, evaluation, technical Japanese texts**

1 Introduction

The aim of this research was to construct a Japanese learning environment for foreign students on the Internet. For students in science and technology universities, there is little time for enrolling in a regular Japanese language course, which involves spending a lot of time on experiments, studies and research, etc. The Internet environment is provided in almost all laboratories and can become an excellent virtual learning environment if there is a Japanese learning system which can be accessed on the Internet anytime and anywhere. The Internet has stimulated many new approaches to language instruction and learning, and it provides a great opportunity to learn one of the most important skills, writing. This is especially true for students in the science and engineering fields who need to write technical texts.

However, almost all CALL systems are concerned with learning how to improve one's reading and listening skills. Few systems are concerned with writing because of the difficulty of implementing an analysis of sentences typed by students who need to learn to phrase their own sentences freely without following any predefined rules. More and more researchers, therefore, use Natural Language Processing (NLP) techniques to analyze learners' typed sentence [9][16]. Recently, NLP techniques designed for use with CALL have attracted special attention (see, for example, [21][22], etc.), as this is expected to help improve writing skills.

Yang and Akahori [28][29] developed a Japanese writing CALL system using NLP techniques which can be used for learning and producing the Japanese passive voice on the WWW. Comparison of two Web-based CALL systems showed that the method of 'free input' and 'feedback corresponding to learners' typed sentence' is better than the method of 'multiple choice' and 'feedback that only displays the correct answer' [31]. Furthermore, an evaluation of the learning histories of the subjects who have actually used the system through the Internet shows that the system obtained a high degree of accuracy and instructional effectiveness [29]. These results demonstrate the effectiveness of the CALL system for writing using NLP techniques on the Internet.

Having sufficient vocabulary and grammatical knowledge is important when learning a foreign language. However, although vocabulary and grammatical rules are provided for correct sentence building in a foreign language, this knowledge alone is not enough. Being able to form correct sentences is by no means enough when it comes to expressing complex thoughts. The major problem for most foreigners learning Japanese is, apart from the writing system, the building of sentences: that is, knowing the corresponding words, the postfixes signaling the word's function (*de*, *ni*, etc.) and the position of the words (verbs final form). It is of paramount importance to learn how to structure one's thoughts: i.e., how to make an outline, how to signal the relative importance of a piece of information, and how it relates to the whole. Therefore, in order to write or to comprehend a structured sentence, it is necessary to learn how to associate sentences, in addition to having a good command of vocabulary and grammar. The connection between sentences can be described as conjunction of adjacent sentences, which is an important criterion for writing a good text as per research in *cohesion* or *discourse structure* [1][3][13][17][26]. Unfortunately, discourse structure is not amenable to single-sentence grammatical analysis, because there are no 'discourse grammars' [11].

Many methods concerning the analysis of discourse structure have been proposed in previous related works. Mann and Thompson's [18][19] rhetorical structure theory (RST) is an influential theory of text structure that is being extended to serve as a theoretical basis for computational text planning. RST postulates that a set of about 25 relations suffices to represent the relations that hold within normal English texts. Most relations have a cue word or phrase which informs the listener how to relate the adjacent clauses. RST can be applied to a computational model. There have been attempts at text generation using RST for the implementation of a prototype of the theory [10][20]. Cue words are also widely used in the identification of rhetorical relations among portions of a text [8][15][24]. Hobbs claims that coherence in conversations and in texts can be partially characterized by a set of coherence relations, which are classified into four categories. Hovy [10] collected and taxonomized the discourse segment relations; this set of relations contains three taxonomies of approximately 120 relations. Hirschberg and Litman [7] also summarize the proposed meanings of items classed as cue words in six computational and linguistic treatments.

In most of these earlier works, emphasis was put on the knowledge that is necessary for recognizing discourse structure. The problem of inference based on that knowledge was also emphasized. However, this does not mean that knowledge can be constructed easily from information available on computers. Constructing common knowledge to implement a practical system is often beyond the capabilities of current NLP techniques. Kurohashi and Nagao [14] proposed an automatic method for detecting discourse structure by checking surface information in text sentences. The information included 'clue expressions', 'occurrence of identical/synonymous words/phrases', and 'similarity between two sentences'. Their result indicates that, in the case of technical Japanese texts, considerable portions of discourse structure can be identified by incorporating the three types of surface information.

Since there are few practical CALL systems that use discourse analysis, the purpose of this study is to develop such a system for helping learners to write technical Japanese texts on the WWW. Section 2 describes the implementation of the system using NLP techniques. The authors took a similar approach to Kurohashi and Nagao [14], namely using surface information in texts. The rules for analyzing technical Japanese texts are based on micro-level (cohesive expressions) and macro-level (headlines) information. Section 3 describes the study that evaluates the effectiveness of the system in two experiments.

2 Implementation of the system

2.1 Method

The combination of cohesive expressions and headlines are employed in the implementation of the system. To examine discourse structure of technical Japanese texts, the classification of basic expressions by Yamazaki et al. [27] is adopted in this study. The reason for this is that their classification covers most of the elements of technical Japanese texts. Based on their findings, the authors have classified cohesive expressions into 15 categories as follows: *comparison, contrast, analogy, cause and reason, basis, composition and enumeration, presentation, definition, classification, hypothesis and conditions, change of state, process of change, change with prerequisites, means and methods, selection*. The total number of expressions is 82. All of the expressions are converted into regular expressions to make the rules. In all, 654 distinctions in the regular expressions were extracted from the 15 categories of cohesive expressions. These formed 654 original rules, which are used in the process of analysis.

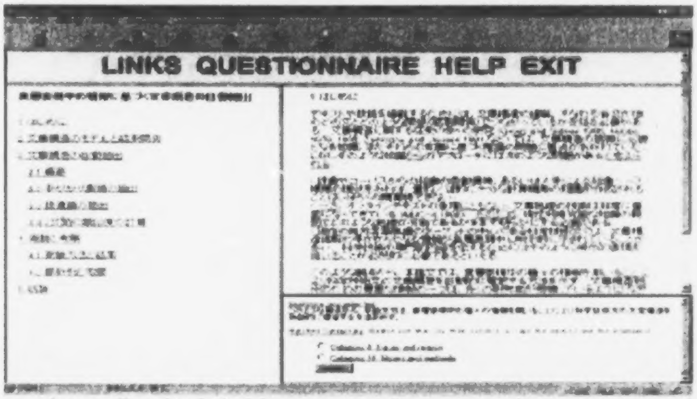
There are two patterns of rules: one is for 'simple pattern matching' and the other is for 'discourse analysis'. The former, called rule set A, is written as a regular expression form and the latter, called rule set B, is written as a regular expression combined with the result of morpheme analysis and syntax analysis. The rule in rule set B is written in a more restrictive form to improve the accuracy of discourse structure analysis. For example, if a sentence is applied to rule set A, it is then analyzed by the morpheme analysis and syntax analysis and the result will be matched to rule set B.

There are many text books on good writing, which nearly all contain a lot of material concerning the different kinds of categories or conceptual bricks at the discourse level out of which texts are built (see, for example, [4][5][6][12][25][26]. However, it is difficult to detect the text structure by just using their framework because it is too extensive and the varieties of different formats used by people for building technical texts too numerous. Instead of predefined framework, headline is used as macro-level information in this study. There are several reasons why the authors decided to use 'headline' instead. First, a well-chosen headline allows the reader to infer the text structure. Second, different formats of texts can be analyzed independently of the texts' style by using the headline. Third, it is easier to understand when the headline is displayed rather than a tree structure because the headline is a part of the original text.

2.2 The discourse structure analysis module

The discourse analysis module of the system contains 'simple pattern matching', 'morpheme analyzer', 'syntax analyzer', and 'discourse analyzer' components. First, the headlines are extracted and the Japanese texts are divided into sentences using several heuristic rules. Then all the sentences in all texts are matched with all the rules in the 'simple pattern matching' component. The 'rules for pattern matching' is used during the process of pattern matching. Because of the exclusive character of almost all of the rules, they are written in order of frequency to reduce the running time on the computer. The frequency of rules is made from the 'rules corpus'. The present system analyzes Japanese text sentences with the morpheme analyzer and syntax analyzer to check the dependency of sentences in the case grammar. Therefore, each cue word in the rules is not only matched against the word itself, but also against the 'parts-of-speech' of the cue word. Only sentences that match the rules written in restrictive form are needed for morpheme analysis and syntax analysis. This takes into consideration the problem of computer running time. The 'rules for discourse analysis' is matched again in restrictive form after the process of syntax analysis. The additional information (parts-of-speech, tense, etc.) is checked to identify the cohesive expressions, especially in the case where one sentence is matched with two or more rules.

Figure 1. One screen shot of discourse structure analysis



The learning page shows a list of technical Japanese texts. Learners can choose any one text by clicking the hyperlink on the list. When learners choose one of the texts from the list, headlines of the selected text are analyzed and displayed first to help learners grasp the whole text structure. Secondly, learners can click on the headline of any part of the text that they want to read. Then the original sentences corresponding to the headline are displayed with the extracted cohesive expressions. The cue words in the cohesive expressions are displayed in color to enable learners to focus on it more easily. Learners can click on any cue words to further find out the cohesive expressions corresponding to the sentences. They can also refer to examples that correspond to the cohesive expressions from the 'examples corpus'. Figure 1 shows one screen shot of the system (text source: [14]). As shown in this figure, the headlines of the Japanese text are analyzed and displayed on the left side of the browser. The headlines show the structure of the text. On the right side, the original sentences corresponding to the selected headline are displayed on the upper part with the cohesive expressions extracted and a link made. When the cue word '*kotoniyori*' (in the first line of the third paragraph) is clicked, the matched cohesive expressions are displayed on the bottom right side of the browser.

2.3 System evaluation of the discourse structure analysis module

A system evaluation is conducted to evaluate the performance of the discourse structure analysis module on 24 technical Japanese texts. The system evaluation is designed for text analysis in two stages (pattern matching in Stage 1 and discourse analysis in Stage 2). The analysis consists of 3 items on both stages: *headline extraction*, *cohesive expression extraction* and *frequency of the rules*. The accuracy ratio of the headline extraction in Stage 1 is 95.22% on average. After a heuristic rule is added, the result of the headline extraction using the revised rules in Stage 2 gained an exceedingly high accuracy rate of 99.17%. The accuracy of the cohesive expression extraction in Stage 1 is 70.23% on average. On the other hand, the accuracy in Stage 2 improved to 92.70% on average. This result shows that using the rules combined with morpheme analysis and syntax analysis gained a higher degree of accuracy than only using the rules of simple pattern matching. After the cohesive expression extraction, the frequency of rules is calculated. The result of 'frequency of the rules' is saved to the 'rules corpus'. The order of frequency is taken as the order of the rules to reduce the running time on the computer.

2.4 The system for supporting technical Japanese texts writing

A CALL system is developed to help learners in the writing of technical Japanese texts. The system is implemented in terms of headlines and cohesive expressions, which is based on the method of the discourse structure analysis module. For headlines supporting, a connection between headline and texts corresponding to the headline is made automatically. Learners can click on any headline to immediately link to the content of texts corresponded to it. For cohesive expressions supporting, examples with the selected cohesive expressions are automatically extracted from the corpus of technical Japanese texts. Learners can refer to these examples to help them improve their writing skills.

The flow of the system is as follows:

(1) Learners register themselves to use the system. An ID number is given after registration. The ID number is used to identify the learner because a log of all learning histories is registered during the operation of the system.
(2) The page for headlines input is appeared. Learners can free input their headlines here. When learners completed their construction of headlines, each headline is automatically linked and displayed on the left side of the browser. The left side of Figure 2 shows an example of linked headlines.
(3) When learners choose one of the headlines, a text box is appeared on the top right side of the browser. Learners can compose their texts corresponded to the clicked headline in the text box. The top right side of Figure 2 shows an example of texts input.
(4) When learners click on the 'basic expressions' button on the bottom right side of the browser, the categories of cohesive expressions is appeared on a new page. Each category is classified further into sub-categories. When learners choose one of the sub-categories from the list, examples are automatically extracted from the corpus of technical Japanese texts and the result is displayed on the bottom of the browser. Figure 3 shows that examples are displayed corresponded to the selected sub-category of cohesive expressions.

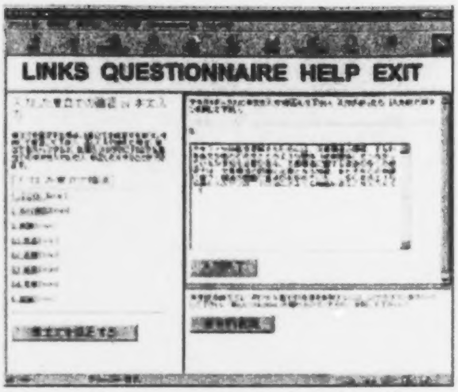


Figure 2. One screen shot of the linked headline and texts input

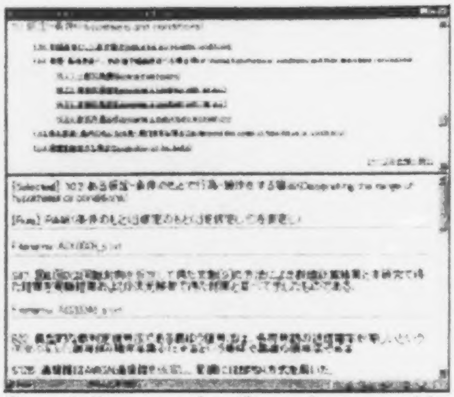


Figure 3. One screen shot of examples extracted from corpus

3 The study

Two evaluation experiments were conducted to examine the effectiveness of the system. The system is evaluated in terms of subjects' intuitive impression and actual usage of the system in the experiment 1 and the experiment 2, respectively. Thirty-three subjects participated in the experiment 1; the other seven subjects participated in the experiment 2. The subjects almost use the WWW and computer everyday.

3.1 Experiment 1

The purpose of the experiment 1 was to examine the functions of the system in terms of subjects' intuitive impression. Therefore, the experiment was designed to make a comparison between the system with the popular and well-known word processor: the MS-Word. During the experiment, the subjects were asked to look at the operation of the system and the MS-Word using video for duration of 10 minutes. The subjects were informed that they would be asked to fill in the questionnaire concerning the comparison of the two systems. The questionnaire consisted of 3 categories: *items of technical sentences writing*, *items of general sentences writing*, and *items of system operation*. The subjects were asked to rate 24 items on a 5-point scale. The subjects were also asked to make comments on the system.

Figure 4 shows the rating of the system and the MS-Word for each item with the 3 categories in experiment 1 and 2. The result of the experiment 1 shows that the system obtained a higher rating than the MS-Word on all of the items of technical sentences writing. For those items of general sentences writing and system operation, the result shows that the MS-Word obtained a higher rating than the system or there was no significant difference on the two systems. However, the system obtained a higher rating than the MS-Word on items 18 ('Sentences can be efficiently made') and 15 ('It is suitable for learning').

Comments on the system are summarized as follows: Almost all of the subjects answered that it is necessary to involve the functions to access other objects, such as figures, tables and numerical expressions, etc. Since the system is emphasized on the discourse analysis of technical Japanese texts using NLP techniques, the target of the system is limited to 'texts'. However, figures, tables and numerical expressions are important components of technical texts. Therefore, development of such visual tools for supporting these objects is expected.

3.2 Experiment 2

The result of the experiment 1 suggests that the system is preferred to the MS-Word on technical texts writing. However, actual usage of the system is not evaluated. Therefore, in order to examine the effectiveness of the system in terms of actual usage of the system by foreign students, experiment 2 was conducted. During the experiment, the subjects were asked to compose a technical Japanese text using the system. The subjects were asked to write sentences concerning their specialization instead of a given task because a variety of subjects' different fields. After the composition is completed, the subjects were asked to fill in the questionnaire concerning the comparison of the system and the MS-Word. The questionnaire is identical to experiment 1, which is divided into 3 categories. Finally, the subjects were interviewed based on their response to the questionnaires.

From Figure 4, the result of the experiment 2 shows that the system obtained a higher rating than the MS-Word on all of the items of technical sentences writing, which is consistent with the result of experiment 1. For those items of general sentences writing and system operation, the result shows that the subjects preferred the system, or the MS-Word or there was no significant difference on the two systems. Comparing this result to experiment 1, the system obtained a higher rating than the MS-Word on items 18 ('Sentences can be efficiently made') and 15 ('It is suitable for learning'), which is consistent with the result of experiment 1. On the other hand, some items obtained different result between the two experiments. These items can be divided into 3 types: First, items 7 ('I want to recommend it to my friends') and 24 ('I want to use it more') are rated from 'no significant difference' to 'a higher rating to the system'. Second, item 2 ('It is friendly') is rated from 'a higher rating to the MS-Word' to 'no significant difference'. Third, item 11 ('It is easy to see') is rated from 'no significant difference' to 'a higher rating to the MS-Word'.

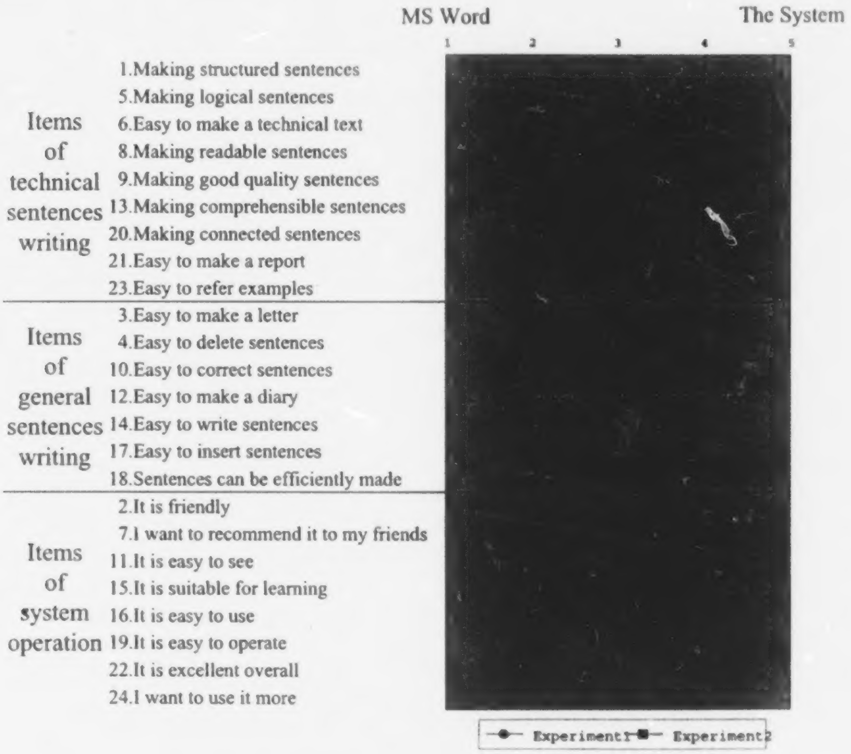


Figure 4. The rating for each item in Experiment 1 and 2

The subjects were asked to give reasons for their responses to the questionnaire items during the interview. The result of the interview concerning the functions of the system is divided into 4 types and summarized as follows: First, for automatically analyzing and displaying headlines, almost all of the subjects answered that it is very useful because they can click on any headline to immediately read the content of texts corresponded to it. The subjects also answered that headlines can be treated as an important role to help them to grasp the whole structure of the texts. Second, for automatically analyzing and displaying cohesive expressions, almost all of the subjects answered that it is very useful because they can find it is easier to convey their thoughts using explicit cohesive expressions. The subjects also answered that it is easy to find their errors because cohesive expressions in the texts are highlighted. Third, for referring to examples from corpus, almost all of the subjects answered that it is very efficient to writing because they can save a lot of time for finding examples from other references. The subjects also answered that they can imitate and learn more examples from the output of corpus. They can learn very much from the process of referring to examples in different texts, especially if there are many different usages in an expression. Fourth, for

Japanese language learning, almost all of the subjects answered that the system is suitable for learning because the system supports learners to learn technical Japanese writing in a structural way in terms of automatically analyzing and displaying headlines and cohesive expressions in technical Japanese texts. The subjects also answered that they can learn not only new cohesive expressions but also correct usages of cohesive expressions even they already know one of them.

Other comments on the system are summarized as follows: Almost all of the subjects answered that it is desired to improve the system to support the functions of electronic dictionary, thesaurus, grammar checking, etc. Therefore, construction of a good electronic dictionary for technical texts writing is considered as an important issue. Moreover, some subjects answered that it is better to extract examples form corpus according to learners' specialization than only random accessing to the corpus. From this result, constructing a corpus should not only consider the number of texts but also the balance of texts in each field.

4 Conclusion

In this paper, the authors describe the development and evaluation of a CALL system for supporting the writing of technical Japanese texts on the WWW. To analyze discourse structure of technical Japanese texts, the rules for analyzing texts are based on micro-level and macro-level information, namely cohesive expressions and headlines. A CALL system for helping foreigners to learn to write technical Japanese texts has been developed using NLP techniques. The system has the following functions: automatically detecting headlines and cohesive expressions in technical Japanese texts, displaying this information on the WWW, and extracting examples from the corpus of technical Japanese texts. The results of a system evaluation show that the system obtained a high degree of accuracy on extraction of cohesive expressions and headlines by using the revised rules set proposed in this study.

The results of the study show that the instructive effectiveness of the system. The result of the interview also shows that the system is not only suitable for technical Japanese writing but also for Japanese language learning. Based on the functions of the system, these results can be explained as follows: First, headlines can be treated as an important role to help learners to grasp the whole structure of the texts. Second, cohesive expressions often explicitly appear in the surface expressions of technical Japanese texts. Thus, it seems important and necessary to use these explicit cohesive expressions to structure one's thoughts in technical Japanese texts. Foreign learners especially may find it is easier to convey their thoughts using explicit cohesive expressions because these can be treated as an indicator of a discourse. Third, the corpus consists of the actual usage in technical Japanese texts from different fields. Instead of predefined examples, examples are automatically extracted from the corpus. Therefore, learners can learn very much from the process of referring to examples in different texts if there are many different usages in an expression. They can also save a lot of time for finding examples from other references.

In conclusion, the system is suitable for learning because the system supports learners to learn technical Japanese writing in a structural way in terms of automatically analyzing and displaying headlines and cohesive expressions in technical Japanese texts.

Acknowledgements

The authors would like to thank Dr. Kikuko Nishina (Professor in the International Student Center, Tokyo Institute of Technology) for her kind help during the analysis of technical Japanese texts. The authors would also like to thank Ms. Cheong Meng-Mei (Tokyo Institute of Technology) for her suggestions and comments on an earlier version of this paper. This study is funded by the Scientific Research Grant from the Ministry of Education of Japan (Subject No. B(2)10558019, Period: from 1 Apr 1998 to 31 Mar 2001).

References

[1]Chan, S.W.K. and T'sou, B.K. (1998). Analyzing Discourse Structure using Lexical Cohesion: A Connectionist Tool. In *Proceedings of the 1998 IEEE International Joint Conference on Neural Networks*, V1: 657-662.

[2]Hajicova, E. (1996). The information Structure of the Sentence and the Coherence of Discourse. In Hovy, E.H. and Scott, D.R. (Eds.), *Computeational and Conversational Discourse: Burning Issues – An Interdisciplinary Account*, 97-107. Berlin: Springer – Verlag.

[3]Halliday, M.A.K. and Hasan, R. (1976). *Cohesion in English*. London and New York: Longman.

[4]Hamada, M., Hirao, T. and Yui, K. (1997). *Paper Workbook for University/Foreign Student*. Tokyo: Kuroshio. [In Japanese.]

[5]Hayes, J.R. and Flower, L.S. (1980). Identifying the Organization of Writing Processes. In Gregg, L. and Steinberg, E. (Eds.), *Cognitive Processes in Writing: An Interdisciplinary Approach*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[6]Hayes, J.R. (1989). Writing as Problem Solving. In Hayes, J.R (Eds.), *The Complete Problem Solver*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[7]Hirschberg, J. and Litman, D. (1993). Empirical Studies on the Disambiguation of Cue Phrases. *Computational Linguistics*, 19(3), 501-530.

[8]Hobbs, J.R. (1979). Coherence and Coreference. *Cognitive Science*, 3: 67-90.

[9]Holland, V.M. and Kaplan, J.D. (1995). Natural Language Processing Techniques in Computer Assisted Language Learning: Status and Instructional Issues. *Instructional Science*, 23: 351-380.

[10]Hovy, E.H. (1993). Automated discourse generation using discourse structure relations. *Artificial Intelligence*, 63: 341-385.

[11]Hovy, E.H. and Scott, D.R. (Eds.) (1996). *Computeational and Conversational Discourse: Burning Issues – An Interdisciplinary Account*, Berlin: Springer – Verlag.

[12]Kinoshita, K. (1981). *The Techniques of Writing for Scientist*. Tokyo: Chuoukouronsya. [In Japanese.]

[13]Kuno, S. (1978). *The Grammar of Discourse*. Tokyo: Daisyukan. [In Japanese.]

[14]Kurohashi, S. and Nagao, M. (1994). Automatic Detection of Discourse Structure by Checking Surface Information in Sentences. *Journal of Natural Language Processing*. 1(1): 3-20. [In Japanese.]

[15]Litman, D.J. (1994). Classifying Cue Phrases in Text and Speech Using Machine Learning. In *Proceedings of the Twelfth National Conference on Artificial Intelligence*, V1: 806-813.

[16]Loritz, D. (1992). Generalized Transition Network Parsing for Language Study: The GPARS System for English, Russian, Japanese and Chinese. *CALICO Journal*. 10(1): 5-22.

[17]Mann, W.C. (1984). Discourse Structures for Text Generation. In *Proceedings of the 10th COLING*. 367-375.

[18]Mann, W.C. and Thompson, S.A. (1987). Rhetorical Structure Theory: Description and Construction of Text Structures. In Kempen, G. (Eds.), *Natural Language Generation: New Results in Artificial Intelligence, Psychology and Linguistics*, 85-95. Dordrecht: Martinus Nijhoff Publishers.

[19]Mann, W.C. and Thompson, S.A. (1988). Rhetorical Structure Theory: Toward a Functional Theory of Text Organization, *Text*, 8(3): 243-281.

[20]Moore, J.D. and Paris, C. (1994). Planning Text for Advisory Dialogues: Capturing Intentional and Rhetorical Information. *Computational Linguistics*, 19(4), 651-694.

[21]Nagata, N. (1996). Computer vs. Workbook Instruction in Second Language Acquisition, *CALICO Journal*. 14(1): 53-75.

[22]Nerbonne, J., Dokter, D. and Smit, P. (1998). Morphological Processing and Computer-Assisted Language Learning, *CALL Journal*, 11(5): 543-559.

[23]Nishina, K. (1997). The Fundamental Research for the Development of Learning System of Technical Japanese. *Doctoral Dissertation*. Tokyo Institute of Technology, Tokyo. [In Japanese.]

[24]Reichman, R. (1985). *Getting Computers to Talk Like You and Me: Discourse Context, Focus, and Semantics*. The MIT press, Bradford Books.

[25]Shimizu, I. (1959). *The Manner of Japanese Writing*. Tokyo: Iwamani. [In Japanese.]

[26]Sugihara, K. (1994). *The Manner of English Writing for Scientist*. Tokyo: Chuoukouronsya. [In Japanese.]

[27]Yamazaki, N., Tomita, Y., Hirabayashi, Y. and Hatano, Y. (1992). *Handbook of Technical Japanese*. Tokyo: Soutakusha. [In Japanese.]

[28]Yang, J.C. and Akahori, K. (1997). Development of Computer Assisted Language Learning System for Japanese Writing Using Natural Language Processing Techniques: A Study on Passive Voice, In *Proceedings of the 8th World Conference on Artificial Intelligence in Education (AI-ED97)*. 263-270.

[29]Yang, J.C. and Akahori, K. (1998a). Error Analysis in Japanese Writing and Its Implementation in a Computer Assisted Language Learning System on the World Wide Web. *CALICO Journal*, 15(1-3): 47-66.

[30]Yang, J.C. and Akahori, K. (1998b). A Discourse Structure Analysis of Technical Japanese Text. In *Proceedings of the Sixth International Conference on Computers in Education (ICCE98)*. Beijing, China. 643-650.

[31]Yang, J.C. and Akahori, K. (1999). An Evaluation of Japanese CALL Systems on the WWW Comparing a Freely Input Approach with Multiple Selection. *CALL Journal*, 12(1): 59-79.

[32]Yang, J.C. and Akahori, K. (2000). A Discourse Structure Analysis of Technical Japanese Texts and Its Implementation on the WWW. *CALL Journal*, 13(2): 119-141.

Development of a Web System to Support Computer Exercises and its Operation

Hajime Kitakami, Sueda Takashi, Yasuma Mori and Susumu Kuroki
Faculty of Information Sciences Research, Hiroshima City University
3-4-1 Ozuka-Higashi, Asa-Minami-Ku, Hiroshima 731-3194, JAPAN
Tel: +81-(0)82-830-1587
Fax: +81-(0)82-830-1587
E-mail: kitakami@its.hiroshima-cu.ac.jp

This paper describes the development and operation of a Web-based system to support computer exercises used in a course on data structures and algorithms. To develop such a system, this paper proposes using the functions of a Web-based system to deal with a learner's state transition model based on computer exercises. The Web system developed by us has useful functions, some of which are the management of participant registration, identification of learner's goals, web service of exercises, mutual interaction between participant and teacher, management of report submissions, and both provision and analysis of electronic questionnaires to participants. The use of this system resulted in students' heightened motivation to work, good communication between participants and teachers, and a reduced workload for teachers.

Keywords: **Web, Database, Exercise, Autonomous Learning, Domain Model, Communication, Questionnaire, Data Mining, Operation, Evaluation**

1 Introduction

The new curriculum of the Department of Intelligent Systems at Hiroshima City University has added computer exercises to subjects related to algorithms and programming, thus encouraging students, from freshmen to sophomores, to make the most of their ability for practical programming with representative algorithms. The curriculum offers two ongoing three-hour courses that include theory and practice.

This paper focuses on computer exercises for the course "Data Structures and Algorithms," which is a part of the core curriculum for sophomore students. The general objective of the course [1, 2] is to facilitate the transition from computer literacy to a professional level of information processing. Even though students have considerable knowledge of computer operations, they do not have perfect command of them. Moreover, they do not have enough experience in basic programming techniques. In order for them to have command of the theory and the practice, we have developed many exercises to improve the management of participant registration and learner's goals, information about the exercises, mutual interaction between participants and teachers, management of report submissions, and collection of questionnaires, among others. However, a problem arises because the workload for both teacher and students increases in the process. To solve this problem, we have developed the necessary support Web system dealing with a learner's state transition model based on computer exercises. Moreover, we report the operational results obtained from real exercises.

2 Assessment of learners' situation before the training

The contents of the courses "Data Structures and Algorithms I" and "Data Structures and Algorithms II" were divided into two courses, each including both theory and practice, using C in the new curriculum. The former includes major elements such as stack, queue, list, naive sort, recursive function, quick sort, tree structure, and binary sort in the second semester of the first year. The latter includes major elements [3, 4] such as complexity, file processing, linear search, binary search, hash, B-tree, pattern matching, graphical searches, Kruskal, and Dijkstra in the first semester of the second year. Since students can easily understand the content of many classes if they have attended C in an earlier semester, "Structured Programming" was also organized into two courses including both theory and practice using C in the first semester of the first year. This course includes major expressions such as if-, while-, and for-statements, array, data types, pointer, function, and structure in C. Moreover, the teaching of computer literacy includes major elements such as word processors (e.g., LaTex), programming tools (e.g., mule, e-macs), drawing tools (e.g., TGIF), the input tool for Japanese characters, electronic mail, X-window, and the shell command on UNIX, among others, in the same semester.

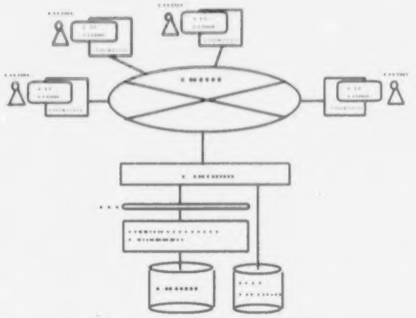


Figure 1. System Configuration

An evaluation of the learners' situation before starting the course "Data Structures and Algorithms II" that is the focus of this paper provided the following results:

(1) Students did not have much knowledge about algorithms and data structures with practical usage. They had learned simple and short programs but did not have much experience with longer programs. For example, they did not have experience in how to update longer programs by themselves.

(2) They did not have enough motivation for autonomous learning. They were less eager to learn than freshmen. For example, they did not consult textbooks or dictionaries on their own when they had trouble understanding an exercise.

(3) Twenty-five percent of the students did not understand the C language. Seventy-five percent of the students tended to forget the C language, since they had not had a chance to practice it for more than 2 months after the second semester of the first year.

(4) Many students did not have sufficient skills to attain perfect command of software tools such as TGIF or LaTex.

3 Conceptual view of the computer exercise

Figure 1 shows the system configuration to support the exercise. Since each learner does his exercises at a workstation connected to the Internet, he can access information managed by the Web server. The Web server stores the exercises as HTML documents. The application program located in the CGI (Common Gateway Interface) manages information related to his registration, personal goals, and questionnaires. The application program is implemented in Parl, Shell, and SQL. The information inputted by the Web browsers is stored in the database and used by the learners.

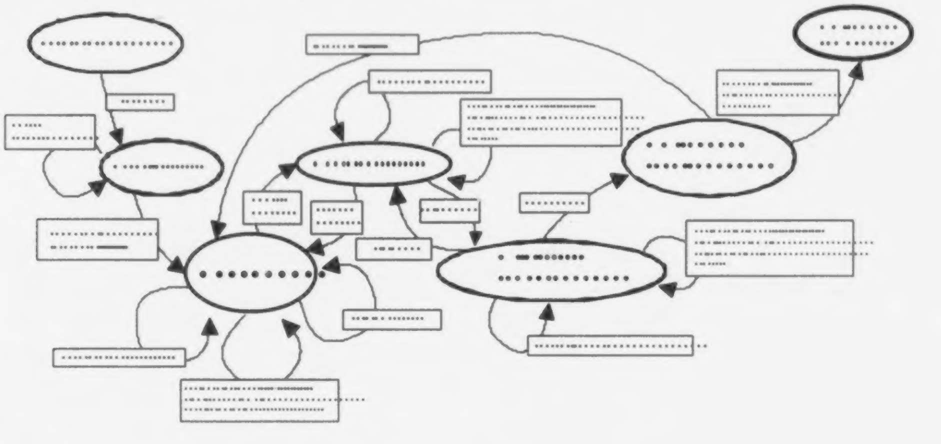


Figure 2. Computer Exercise Model

We tried to computerize human work as much as possible in the existing computer exercise. Notice of all 15 exercises included in the course was given on the Web page. We connected both basic programs and measurement data to the Web page for each exercise. Using a Web browser, both could be downloaded from the Web server to a student' s site. Before starting on the first exercise, students had to fill out an electronic registration form for the class using the Web browser. When a student inputted his school number, name, password, and e-mail (electronic mail) address in the registration form, the system issued him a registration number using e-mail and the Web page. If the student needed any information about the exercises after that, he could get it by inputting his registration number and password using the Web browser.

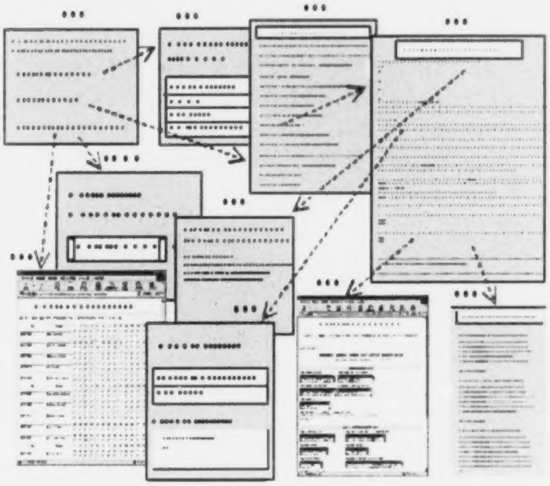


Figure 3. An Example of System Operation

Figure 2 represents the state transition for the computer exercise model. "Starting the Course," located at the left side of Figure 2, represents the state before starting the class. The student moves to the state of "Completing the Course" if he finishes all exercises successfully. If the student inputs personal data in the class registration form, the student moves to the state of "Class Participant." If the participant replies to the first questionnaire and inputs his personal goals for the exercise using the Web browser, he moves on to the state of "Exercising." At this stage, the learner is allowed to solve the exercise. If the learner inputs a question to the teacher on the Web page, he receives a reply from the teacher on the Web page. After finishing the exercise, the learner moves on to the state of "Making the Report" and can answer our questionnaire for the exercise as he finishes the exercise. If the learner submits his report to the teacher, he moves on to the state of "Waiting for the Evaluation." If the evaluation is poor, the teacher contacts the student, helps him, and asks him to re-submit the exercise. The Web system does not support their interaction in the situation, since we believe that face-to-face communication is preferable. This situation is different form Fujimoto's Classroom Management System [5]. After the learner reaches the state of "Completing the Submission," he will input his personal goals for the next exercise. After that, he will move to the state of " Exercising."

We place great importance on the use of educational methods [6, 7] including "Reading, Writing, and Using an Abacus" to achieve the goal of "autonomous learning and thinking." For students belonging to the categories (1)-(4) mentioned above, the computer exercise model includes the following educational methods. Students in (1) and (3) are asked to read longer programs downloaded from the Web server, write the respective flowchart, update the subparts, and measure their performance in the state of "Exercising" shown in Figure 2.

Students in (2) are asked to define their personal goals before reaching the state of "Exercising" and write a self-evaluation in the state of "Making the Report." In the state of "Exercising," students are given an ambiguous exercise to learn the value of searching for information. In this way, students are encouraged to develop their creativity skills. Moreover, students are strongly advised to use textbooks and dictionaries if they have unresolved questions. Students in (4) are strongly encouraged to use such tools as TGIF and LaTex when preparing a report that includes figures and text. We believe that longer programs particularly enhance their proficiency in using tools. In order to determine an accurate grade for each exercise, we evaluate the reports submitted by the students and their answers to the questionnaires. Since we receive the results of the questionnaires immediately through the Web, we use such results to improve the exercises and coach the students. Moreover, the students can also receive their scores in a very short time. Students can compare each other' s scores if they are given access to the statistics. Giving students access to the statistics is regarded as the key to ensuring an environment of awareness [8].

4 The results of system operation

Figure 3 represents an example of the operation of the system. Web page number (1) in the figure relates to the state of "Starting the Course." Page (2) is the class registration form. Page (3) gives anchors for information about all 15 exercises included in the course. If a learner selects one of the exercises on the page, he can use the exercise page (4). He can access his record of submissions and re-submissions using Web page (5). After inputting his personal goals using Web page (6), he moves on to the state of "Exercising." When he finishes the exercise, he moves on to the state of "Making the Report" and inputs the questionnaire on Web page (7). The results of the questionnaires are immediately stored in the database. Not only the teacher but also the learners are able to compute the statistics of the results from the database in real time. Page (8) relates to the statistics. Pages (9) and (10) are for teachers' use only. In page (9), each student has 15 check boxes, each divided into an upper and a lower section. If the report evaluation is good in the state of "Waiting for the Evaluation," the teacher puts a checkmark in the upper check box. If not, he puts the checkmark in the lower check box and helps the student so that he re-submits his work. Page (10) is useful for analyzing questionnaires stored in the database. The analysis includes the method of data mining [9] implemented in SQL.

Application of the system operation started at the Department of Hiroshima City University in April 1999. This system motivates students to do their exercises, provides good communication between participants and teachers, and reduces teachers' workload. The evaluation results of questionnaires and examinations related to the exercises are as follows:

(1) Ninety percent of students studied for 0.5-2.0 hours at their homes and were interested in the lecture.
(2) Twenty-six percent of students spent less than 2.0 hours preparing the report and exercising, 53% spent 2.0-5.0 hours, and 21% spent more than 5.0 hours, not including class work.
(3) Seventy percent of the 12 students (25%) previously mentioned understood the C language. Moreover, all students made progress in their studies.
(4) Ninety-five percent of the students reported good understanding of the algorithms used in the exercises. Eighty-seven percent of the students passed the examinations.
(5) The students acquired good skills at using TGIF, LaTex, and other programs to write reports.
(6) Seventy percent of the students felt that the teacher did his best in the classroom, and 17% of them barely approved of his performance.

5 Conclusions

We proposed a computer exercise model for the course of "Data Structures and Algorithms II" and developed a Web support system for computer exercises using the model. We place great importance on educational methods including "Reading, Writing, and Using an Abacus" so that our students acquire the skills of "autonomous learning and thinking." Computer exercises using the Web system give students a chance to enhance their capabilities of "autonomous learning and thinking" and "creativity." The system run on the Web server has useful functions, some of which are the management of participant registration, identification of learner's goals, web service of exercises, mutual interaction between participants and teachers, management of report submissions, and both provision and analysis of electronic questionnaires to participants. The use of the system resulted in students' motivation to do the exercises, good communication between participants and teachers, and a reduction of teachers' workload. In order to achieve more concrete results, the students studied more at home and were enthusiastic about doing their exercises. Moreover, the students learned how to make a report using TGIF, LaTex, and other programs.

Acknowledgements

We thank Assistant Professor Dr. Akira Sato of Hiroshima City University for his help with the exercises. We also thank Mr. Jun Ogawa, Mr. Takashi Maesako, and Mr. Kohei Matsumoto, TAs (Teaching Assistants) of Hiroshima City University, for their help with the exercises. This work was supported in part by a Grant-in-Aid of Scientific Research (C) from the Japan Society for the Promotion of Science and a Hiroshima City University Grant for Special Academic Research.

References

[1] Denning P. J., Comer D. E., Gries D., Mulder M. C., Turker A., Turner A. J., and Young P. R.: Report of the ACM Task Force on the Core of Computer Science, Association for Computing Machinery Press (1988).

[2] Computer Science Educational Curriculum for B. A. Degree Program in Computer and Engineering J97, Information Processing Society of Japan, 158p. (1997).

[3] Aho A. V., Hopcroft J. E., and Ullman J. D.: Data Structures and Algorithms, Addison-Wesley (1983).

[4] Leendert A.: Programs and Data Structure in C, Second Edition, John Wiley & Sons (1992).

[5] Fujimoto R., Suganuma A., and Mine T.: Development of a Classroom Management System on the Web, Advanced Research in Computers and Communications in Education (ICCE'99), Ed. by Cumming G. et al., Vol. 55, IOS Press, pp. 756-759 (1999).

[6] Angelo T. A.: Beginning the Dialogue: Thoughts on Promoting Critical Thinking, Teaching of Psychology, Vol. 22, No.1, pp. 6-7 (1995).

[7] Kuhar M. B: Critical Thinking: A Framework for Problem Solving in the Occupational Setting, AAOHN JOURNAL, Vol. 46, No.2, pp.80-81 (1998).

[8] Dourish P. and Bly S.: Portholes: Supporting Awareness in a Distributed Work Group, Proc. of CHI'92, pp.541-547 (1992).

[9] Fayyad Usama M., Piatestky-Shapiro G., Smyth P., and Uthurusamy R.: Advances in Knowledge Discovery and Data Mining, AAAI Press/ MIT Press (1996).

Development of CAI System with Character Code Discrimination on WWW Environment

Hiroyuki Watanabe and Katsuhiro Kato
Department of Electrical and Electronic Engineering, College of Engineering,
Nihon University
1 Nakagawara, Tokusada, Tamuramachi, Koriyama, Fukushima 963-8642, Japan
E-mail: {hiroyuki, kkatoh}@ee.ce.nihon-u.ac.jp

1 Introduction

The CAI systems on the Worldwide Web are accessed by learners all over the world. However, the server-client type CAI system has a problem in that the character code does not translate into other character codes. Therefore, in the previous CAI system[1], the S-P chart used for data analysis was readable only in the Japanese version[2]. The new client program runs Java applet corresponding to the character code of the learner's language and the character code in the tag is transferred to the server together with the learner's data. The character code in the tag is decoded on the server side, and the HTML file provides the S-P chart. As a result, even if the CAI system is accessed from various countries, the character code of the learner's language, such as Japanese or English, can be decoded by one server program and the S-P chart corresponding to the character code can be provided.

2 Flowchart for the Character Code Decoding

This CAI system is constructed through the WWW client program with Java applet corresponding to the character code of the learner's language, and the WWW server program with the Java application[1]. Below is a description of the process. (see Fig. 1).

(1) The Japanese or English learner selects Java applet in Japanese or in English, respectively. The questions or hints are displayed. The learner's answer is judged via the WWW client program which is online.

(2) When the WWW client is only one Java applet, the WWW server has a character code error for the difference between the languages of the client and the server. For character code decoding the following code is added in the tag by Java applet.

```
<GET> M dir_name learner_name JPN
..for Japanese
<GET> M dir_name learner_name ENG
..for English
```

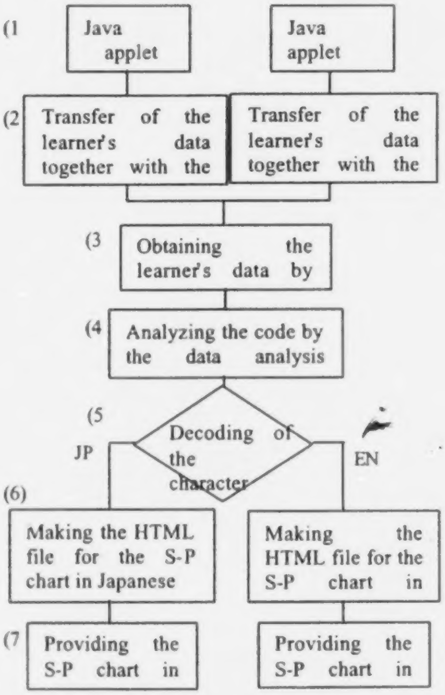

(1
Java applet
Java applet
(2
Transfer of the learner's data together with the
Transfer of the learner's data together with the
(3
Obtaining the learner's data by
(4
Analyzing the code by the data analysis
(5
Decoding of the character
JP
EN
(6)
Making the HTML file for the S-P chart in Japanese
Making the HTML file for the S-P chart in
(7
Providing the S-P chart in
Providing the S-P chart in

Fig. 1: Flowchart for the character code

The "<GET>" is one of the tags transferred from the client to the server. The code "M" is the data management related to the language. The "dir_name" is the directory name of the courseware for the saving of the learner's answers. The "learner_name" is the learner's name. The last code "JPN" or "ENG" is the character code of each learner' s language.

(3) The character code together with the learner's data, which includes the learning score and its time, are obtained by the WWW server program through the Internet or the Intranet.

(4) Even if the language code is different, the learner's data is saved with the same file name in the same directory for the courseware. The learner's data is managed collectively, and the data analysis program analyzes the character code in the tag.

(5) The character code difference between Japanese and English is decoded.

(6) The learner's ranking is placed with the data of all learners, which has been stored in the server for each courseware. The S-P chart and the result of the statistical analysis which is formatted by the HTML are made corresponding to the character code of each learner' s language.

(7) The S-P chart with the character code of each learner' s language is provided to the WWW client.

3 Results

Fig. 2 shows the S-P chart in English for the score. The score for each learner is sorted vertically to the smallest value, which is the S-curve, and the score for each question is sorted horizontally to the smallest value, which is the P-curve. The S-P chart displays the learner's ranking. The attention coefficients for each learner and each question are shown. Furthermore, the evaluation of the learner, the average and its standard deviation are also shown. The S-P chart can also be accessed and displayed in Japanese.

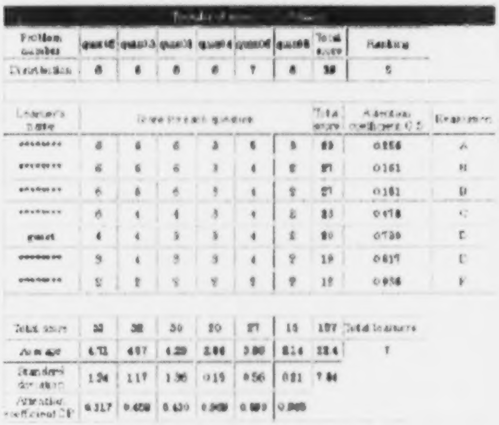


Fig. 2: S-P chart in English.

4 Conclusions

For a good study, it is important that the S-P chart be provided for the learner. In this paper, the character code corresponding to Japanese or English, together with the learner's data, is transferred to the server from the client by Java applet. The S-P chart, which is written in Japanese or in English, could be provided by one server program making the HTML file corresponding to the character code of the learner's language. As a result, many server programs will not need to prepare character codes for the learner's language. This should increase the number of learners and give learners more definitive rankings. Each learner can access the courseware by typing the following URL through the Internet.
http://133.43.15.87/~webcai/index_e.html

References

[1] H. Watanabe & K. Kato, "Development of the ICAI system in WWW for individualized education", Proceedings of the 5th International Conference for Young Computer Scientists (ICYCS'99), Nanjing, China, Aug.17-20, pp.966-970, (1999).

[2] H. Watanabe & K. Kato, "An analysis of response time distribution for CAI courseware", Proceedings of the 7th International Conference on Computer in Education (ICCE' 99), Chiba, Japan, Nov.4-7, pp.125-132, (1999).

Development of Cross-Cultural Communication System and Web-based Japanese Education

Lumi Tatsuta, Yaeko Nakanishi , Masayuki Ohnishi, Atsuo Iguchi[*] ,
Giichi Tomizawa[**] and Kimiko Gunji[***]
**Dokkyo University(Japan) • •*
***Science University of Tokyo(Japan)*
****University of Illinois(UA)*
1-1 Gakuen-cho Soka, Saitama Japna 340-0042
tatsuta@dokkyo.ac.jp

In 1998 we presented a framework and system construction of "Images of Japan," a learning system of the Japanese culture and language in Beijing, China. In this paper, we discuss the results of our initial evaluation of its framework and system based on personal feedback from students and on the responses to the survey carried out in the form of questionnaires. Even though the overall assessment was positive, we have received a few suggestions for improvement. We are now working on the implementation of improvements, some of which we also introduce here.

Keywords: **Cross-Cultural Communication, Japanese Education, Communication Tool**

1 Introduction

"Images of Japan" was constructed to develop an effective network-based learning environment of cross-cultural communication: disseminating information on Japanese culture and providing opportunities to learn Japanese. In order to encourage active participation and to keep the users motivated to share their knowledge and develop a deeper understanding which they could not achieve alone, we have had Japanese students and non-Japanese students select items which they want to introduce or they want to know. More than 300 items have been collected. The data also reveal that there is a wide gap in their perception of Japanese culture, particularly between Japanese and non-Japanese students. We expected that this perceptional gap between the Japanese and foreign students would serve to facilitate cooperative and collaborative learning and sharing of knowledge among the users and to lead to their active participation in the program.

2 The Framework of the System and its Evaluation

Users can jump from the top page to any pages by clicking the icons installed in the index. Since this courseware is primarily constructed to show the diversity of Japanese society and to encourage Japanese and non-Japanese students to think about Japanese culture and to share opinions and ideas with each other, the pages of Classification and Collaboration are the central parts of this framework. Over 300 cultural items are presented in the Classification page. In the Collaboration page, "Bulletin Board," "E-mail," and "Voting," devices are installed. The "Bulletin Board" serves not only to link together Japanese students and non-Japanese students giving them opportunities to chat or exchange information, but also to provide data to evaluate the effectiveness of this collaborative learning program. .

In the "Voting" users are encouraged to vote for the items in which they are interested. Users can also add new items of their own choice in the existing page. The ranking is continuously updated so that users can feel a sense of participation and maintain their interest. In addition to "Bulletin Board" and "Voting," "Questionnaire Page" was later added to obtain direct opinions from the users and to evaluate how much collaboration and development of knowledge has been achieved. The Questionnaire basically consists of multiple-choice questions. As evaluation based on these means should be carried out through a long span of time, however, we have decided to perform an experimental assessment in the form of a questionnaire in the meantime. The number of responses collected was 63 in total (51 Japanese and 12 non-Japanese students.) Questions focus on the following themes; (1) the overall framework, (2) information on the Japanese cultural items, and (3) the Japanese language learning program.

3 Results of the Questionnaire on the Overall Framework

In the evaluation of the overall framework, the following issues were addressed. The responses turned out basically positive.

Table.1

	Good	bad
Accessibility of items	78%	22%
Layout	92%	8%
Linking	98%	2%

Table.2

	very good	good	not good	bad
Size of the letter and presentation	12%	80%	6%	2%
Screen presentation	12%	80%	8%	0%
Control of Screen	8%	80%	10%	2%

Table.3

	Very interesting	Interesting	Not interesting
Photo picture	8%	78%	16%
Illustration	14%	53%	33%
Animation	20%	68%	12%

With regard to question of "Accessibility of items," however, 22% of the students responded negatively. The reasons could be multifold. The list of cultural items could be too numerous for participants to screen them thoroughly. The instructions on how to use the page might have been inadequate. A few students might not be able to plug in the page. Also, a minor technical problem might be present. However, the quantity of photos, illustrations, animations and sound is controlled so that users will not find them overwhelming. In any case, improving the accessibility is one of the issues that requires further study. On the other hand, we feel that the number and wide variety of cultural items, which might look overwhelming to some viewers, is in fact an important advantage. At the moment each one of those items is categorized into sixteen major subjects, and the users have to select one of the major subject first to reach the page of each item. How to arrange topics so that the users will find them easy to access is an issue to be studied as well.

4 Japanese Cultural Items

Traditional events

Fig.1 Example 1

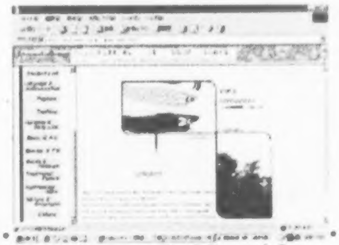


Fig.2 Example2

The above are examples of a cultural page. Each item basically consists of two pieces of visual information either in the form of photos , illustrations or animations, followed by the comments or brief information given by the students who participated in the original survey are given. In the survey, the following four questions were asked. As shown in the figures, their responses turned out less positive than those on the "Overall Framework".

(1) Could you understand the ways young students grasp Japanese culture?

Japanese students	Yes 76%	No 24%
Non-Japanese students	Yes 100%	No 0%

(2) What do you think of this home page on Japanese culture introduced by students?

Japanese students	Useful 55%	Not useful 6%	Interesting 31%	No Answer 8%
Non-Japanese students	Useful75%	Not useful 0%	Interesting 25%	No answer 0%

(3) After having read these pages, have your ideas towards Japanese culture changed?

Japanese students	Yes 37%	No 63%
Non-Japanese students	Yes 100%	No 0%

(4) Do you want to exchange your ideas with others on the "Bulletin Board?"

Japanese students	Yes 71%	No 29%
Non-Japanese students	Yes 100%	No 0%

The reason for the negative response is in part due to lack of sufficient information on each item. Particularly, the responses from Japanese students are much less positive than those from foreign students. On the other hand, written responses from foreign students were quite favorable: saying, e.g.,

"This is a fascinating resource to learn more about Japanese culture," "I think the items introduced here are very thorough, everything from traditional to modern culture." This wide difference in the response between Japanese and non-Japanese students is basically due to the fact that those non-Japanese students are the ones who are already interested in Japanese culture and willing to learn more, while most of the Japanese students are not necessarily interested in Japanese culture, or the items presented here are not enticing but too familiar to them. The objective reasons for the negative reactions should be sought for, too. It is also evident that we have to improve the Japanese Cultural Page so as to encourage students to share their knowledge and opinions actively and enhance their cross-cultural communication skills.

5 Improvements

In order to ensure that students will use our program as a source of information about Japanese culture and as a tool for cross-cultural communication, we have to make it more attractive for them. As a first step, we are now working on a construction of a "Discussion Room.," where two groups of students, Japanese and non-Japanese, exchange their ideas, feelings, and opinions on a series of scenes excerpted from Japanese movies (one is "Funeral" and the other is "Shall We Dance?") These two movies not only reflect ways of thinking of Japanese people but also its conventions of daily life and will serve as an interesting source of cross-cultural communication. Another group of students is assigned to discuss "Bushidoo vis-a-vis Knighthood," and the fourth group of students should discuss a topic of their own choice. We expect that through these activities the students will experience both satisfaction and frustration in communicating with other people of different cultural backgrounds. The conversations recorded in the Discussion Room are being accumulated and will be analyzed as a source of studying cross cultural communication.

As for the Japanese language Program, we could not obtain sufficient feedback from the foreign students The language program was made for intermediate students. However, since the number of foreign students who have reached intermediate level Japanese in this first experimental evaluation was limited, we could not obtain concrete comments or reactions on the program. At the time when we constructed the language program, we could not provide appropriate audio information nor video due to the problem of network speed. Since this problem has been solved, however, we are now not only adding sound to the original program but also constructing a new listening comprehension page. The listening comprehension is geared to basic level students. By doing so, a more active use of this program will be expected. It will be also used in class starting this October and the feedback from the students will be duly analyzed and be used for further improvements.

6 Future Plans

The results of the initial experimental evaluation have suggested that this home page could be a good source of information on Japanese culture. However, they also have revealed that some changes in the framework as well as in the content of the cultura l and language pages should be made in the near future. Some of those changes are now being made as mentioned above. The program also needs to expand to include the participation of other universities, particularly those which they have a Japanese language program or course on Japanese culture. After implementing further improvements and having obtained a sufficient number of responses, we will reevaluate the home page.

References

[1]Barthel, Alex(1998)"The user of computer technology in the teaching of speaking touniversity students" Proceedings of ICCE98 Global Education on the Net Japanese Learning System: hhtp://www2.ak.cradle.titech.ac/jp/japanese

[2]Murphy, Kare L.(1998) "A Constructivist Look at Interaction and Collaboration via Computer Conferencing" International Jl. of Educational Telecommunications 4 (2/3)

[3]Nakanishi,Y. (1999) "On Evaluation of a Collaborative Learning System for Japanese and Japanese Culture" Dokkyo University International Center

[4]Ogata, Hiroaki & Yano, Yoko(1998) "Knowledge Awareness: Bridging learners in a CollaborativeLearning Environment" International Jl. of Educational Telecommunications 4(2/3)

[5]Tatsuta, Rumi, et.al (1998) "Images of Japan" -- "Collaborative Learning System for Japanese and Japanese Culture" Proceedings of ICCE98 Global Education on the Net Japanese Learning System

[6]Tatsuta, Rumi, et.al (1998) "Development of a collaboration system on Internet in order to enhance the understanding of Japanese Culture" Dokkyo University Studies of Economics Nol68

[7]Y. Nakanishi, L.Tatsuta, et.al (1999) "On Experimantal Evaluation of a Collaborative Learning System for Japanese and Japanese Culture" Advanced Research in Computers and Communications in Education

Domain Specific Information Clearinghouses – A Resource Sharing Framework for Learners

Wong Pei Yuen*, Yeo Gee Kin*, David Crookalland Lua Tse Min***
**Department of Information Systems*
School of Computing
National University of Singapore
Building S-15, Level 5, Room 12
3, Science Drive 2, Singapore 117543
Tel: +65 874 2908 Fax: +65 779 4580
E-mail: {wongpei1, yeogk, luatsemi}@comp.nus.edu.sg
***UNSA, Langues, 98 bd Herriot, BP 209, 06204 Nice cedex 3, France*
E-mail: crookall@jaydemail.com

The World Wide Web has presented researchers and learners all over the world with unprecedented opportunities to find and distribute information. An increasing number of valuable resources are made available online. This provides an excellent knowledge base for learners. However it is often very difficult to find these useful resources. This paper describes the framework of a domain specific information clearinghouse and how these clearinghouses can collaborate with one another to enable cross-domain learning. The resources in a domain-specific clearinghouse are submitted by trusted domain experts to ensure its quality. Learners with multiple domain interests can also effectively retrieve the information they need using the cross-domain collaboration framework presented. This is achieved with a union agent that manages the collaboration and sharing of resources between different domains. We also present a toolkit that facilitates the rapid deployment of such clearinghouses by domain experts.

Keywords: **Collaborative Learning, Educational Agent, Knowledge Construction and Navigation, Web-Based Learning, Domain Specific Information Clearinghouse**

1 Introduction

The tremendous success of the Internet and the World Wide Web has resulted in a global information revolution. With more and more information easily available online, people are now increasingly reliant on the Web for their information needs. They are constantly faced with the problem of finding relevant information that will suit their learning needs. Most commonly used tools for finding information, in particular search engines and Web directories, often return huge amounts of information which are neither useful nor relevant to the learners' needs. A more effective way of assisting these learners in finding information is lacking.

A possible solution would be the use of a domain-specific information clearinghouse managed by human domain experts. In a nutshell, a *Domain Specfic Information Clearinghouse*, or *DSIC*, is a Web-based clearinghouse and resource repository for information resources available on the Web. Learners would be able to find relevant and higher quality information from these resources. However, most information and research nowadays do not dwell on a single domain. Cross-domain learning requirements need to be met. This can be achieved through collaboration between multiple DSICs. With this cross-domain collaboration, we are able to discover and learn more about how each domain is related to one another.

In the following sections we will discuss the various approaches that are currently adopted by learners and the concept of the Domain Specific Information Clearinghouse. Section 4 describes the framework of a Domain Specific Information Clearinghouse network to facilitate cross-domain learning. In Section 5, we describe a toolkit currently under development for the quick deployment of a domain-specific information clearinghouse. Finally, we would conclude with Section 6.

2 Current Approaches for Finding Information Online

The primary means by which learners find information on the Web are tools like search engines, Web directories and metasearch engines [1] [5].

Search engines operate by plowing through the Internet and indexing web pages. Typically, only keywords are indexed. Some examples of search engines are AltaVista[1] and Hotbot[2]. Using this method, a lot of information can be retrieved. However, there is a trade off between quantity and quality. In this huge list of results, though it may contain many relevant items, most of the search results are usually irrelevant. Learners will lose a lot of time following useless links.

Web directories like Yahoo![3] and Excite[4] are maintained manually by a dedicated group of catalogers. These directories contain user-submitted resources that are indexed categorically. These indices are usually human-created or computer-generated. They would usually include some description that helps the user in determining the usefulness of the resource. As the resources contained by Web directories are user-submitted, there is the problem of scalability: it is impossible to scale personnel to match the rate at which the Web is growing. Web directories are outdated rapidly due to the ever changing and ever growing Internet. Important resources for the different categories and topics are often missing.

Metasearch engines are web tools that poll multiple sources like search engines and Web directories. The compiled resources are then processed and returned as results to the user. Metacrawler[5] and SavvySearch[6] are examples of metasearch engines. However, as pointed out in [4], although metasearch engines can significantly increase coverage, they are still limited by the engines they use with respect to the number and quality of results.

After looking at the above approaches, the problem of finding relevant and useful resources is not solved. Although these approaches may be adequate for a casual Web user, they do not serve learners who require specific information from certain domains well. We shall discuss our proposed solution in the next section.

3 Domain Specific Information Clearinghouse

Figure 1 below depicts the DSIC model.

---

[1] http://www.altavista.com
[2] http://www.hotbot.com
[3] http://www.yahoo.com
[4] http://www.excite.com
[5] http://www.metacrawler.com
[6] http://www.savvysearch.com

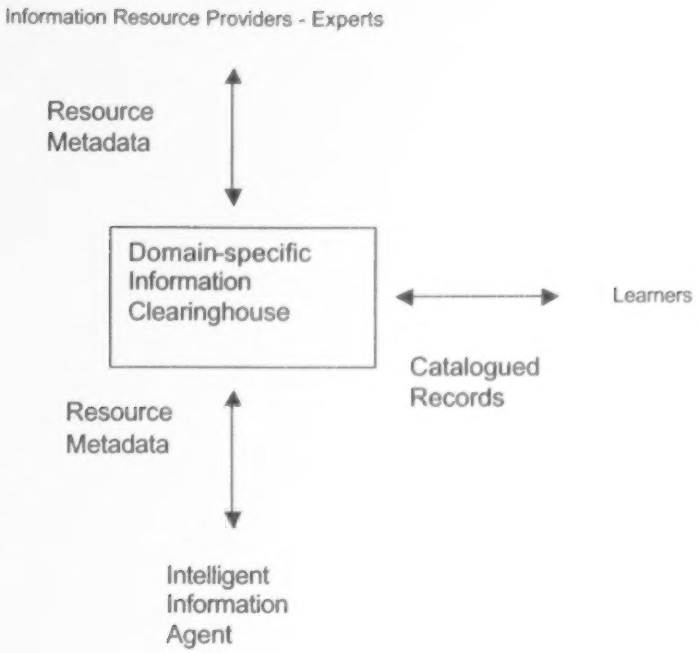

Information Resource Providers - Experts
Resource Metadata
Domain-specific Information Clearinghouse
Learners
Catalogued Records
Resource Metadata
Intelligent Information Agent

Figure 1: Domain-Specific Information Clearinghouse Model

As mentioned earlier, a Domain Specific Information Clearinghouse is a web-based clearinghouse and resource repository for domain-specific resources available on the web. One or more domain experts maintain the resources found in the clearinghouse. From now on, we will refer to *experts* as people who supply information to the clearinghouse and *learners* as people who access the clearinghouse for information.

The clearinghouse contains a classification of topics found in the domain and an intelligent information agent. With a good classification, the clearinghouse would be better organized and would increase learners' ease in finding the information they want. An intelligent information agent should be made available to facilitate the knowledge sharing and exchange both within and outside the clearinghouse.

An expert registers with the clearinghouse as a trusted information provider. He will then be able to submit resources that are in turn classified and cataloged. Using information found in these submitted resources, the intelligent information agent could scour the Web for more resources that can be added into the clearinghouse. The quality of these resources is much higher as they are being submitted by domain experts. What is useful and relevant to these experts are also usually useful to the learners as well. With all these information clearly classified, learners can then search or browse through the resource collection effectively in the domain specific clearinghouse.

4 Cross-Domain Learning

The DSIC caters to the needs of experts and learners in a single domain. However, learners often have not just one but multiple domains of interest. It would be useful for a learner with multiple domains of interest to be able to find the information he needs across all the different domains. Moreover, there are often no clear boundaries between domains, as the figure below shows. Resources from different but related domains may overlap.

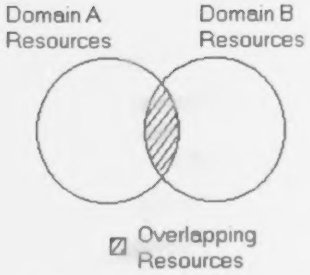

Domain A
Resources
Domain B
Resources
▨ Overlapping
Resources

Figure 2: Overlapping Domain Resources

This potentially allows for different DSICs to collaborate and share resources with each other. To provide such a resource sharing framework, two issues needs to be addressed: distributed service and metadata exchange.

4.1 Distributed Service

The proposed framework for collaboration between multiple DSICs is essentially a distributed service. Domain experts maintaining each individual clearinghouse would register it with the *information union agent*, which is a central service that keeps track of all the existing clearinghouses that has been set up. This is illustrated in Figure 3 as follows:

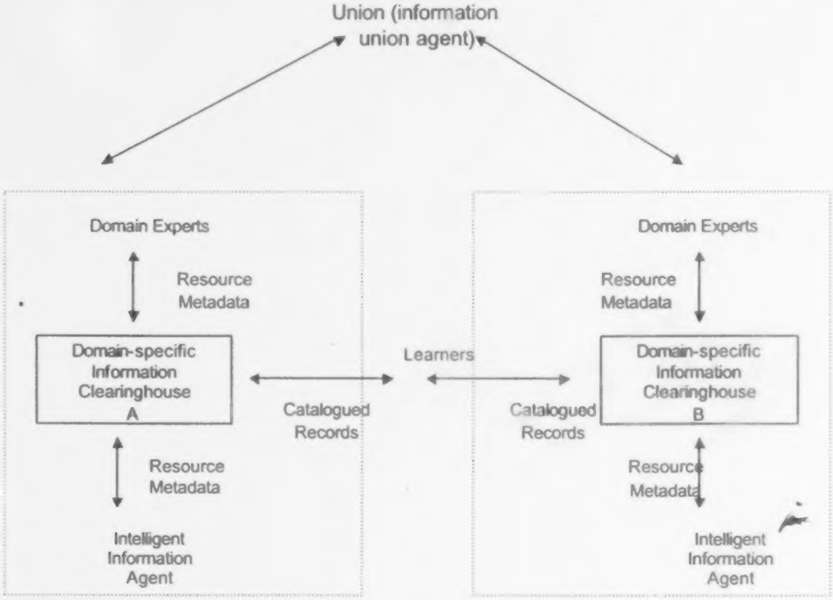

Union (information
union agent)
Domain Experts
Resource
Metadata
Domain-specific
Information
Clearinghouse
A
Resource
Metadata
Intelligent
Information
Agent
Catalogued
Records
Learners
Catalogued
Records
Domain Experts
Resource
Metadata
Domain-specific
Information
Clearinghouse
B
Resource
Metadata
Intelligent
Information
Agent

Figure 3: Multiple Domain Resource Sharing

Upon registration with the information union agent, each clearinghouse would declare the metadata attributes that are used to describe resources in that particular clearinghouse. Relationships with other domain clearinghouses are also declared. This information is then broadcasted to all the clearinghouses in the union to facilitate metadata exchange, which will be discussed in section 4.2

Besides maintaining the relationship links between the different domains, the information union agent would also apply data mining techniques to learn and discover relationships between resources in the different domains. For example, when the number of similar resources that are found in two different categories of different domains exceed a threshold value, the union agent would automatically update the union with this relationship if it has not already done so. Through this process, the union agent can learn and discover new information and relationships between different clearinghouses in the union and update the respective clearinghouses with the new information. This allows the clearinghouses to provide learners with higher quality information.

4.2 Metadata Exchange

A DSIC union needs to provide a mechanism to facilitate the exchange of machine-understandable information among different DSICs. Being domain specific, each DSIC has its own set of metadata attributes and values. A mechanism needs to be provided for a DSIC to automatically interpret metadata that comes from another DSIC of a different domain and transform it to a human-readable form. This problem is non-trivial because classification schemes and metadata formats can vary widely between different DSICs.

The *Resource Description Framework* [7], or *RDF*, is an evolving specification developed by the World Wide Web Consortium. RDF's nucleus is an archetype for depicting named properties and their values. The properties are representations of resource attributes as well as the relationships between resources. This data model provides a syntax-independent means of representing RDF expressions.

We have developed a mechanism adapted from the RDF standard that would suit the needs of the DSIC union. We called this mechanism the *Metadata Schema*.

A metadata schema is simply a set of attribute names that is used to describe all the resources cataloged in a particular DSIC uniformly. Each DSIC is associated with exactly one metadata schema at any one time.

A metadata schema is unambiguously represented by an ordered n-tuple of the form

$$< N_1, N_2, N_3, \ldots, N_n >$$

In the above notation, each N_i, $i \in \{ 1, 2, 3, \ldots n \}$ can be any sequence of alphanumeric characters, including spaces, that starts with a letter. Usually, these would correspond to attribute names such as "Author", "Company", "Description" and "E-mail Address".

The Metadata Schema, together with the information union agent, are the main mechanisms for interoperability between different DSICs. The following scenario illustrates how the Metadata Schema is being used.

A learner using a particular DSIC X to search for information can indicate that he wants to cross-search another DSIC Y. Through the union agent described in Section 4.1, DSIC X would already know the Metadata Schema of DSIC Y and would request DSIC Y for metadata records that correspond to the user's search request. DSIC Y would then respond with a set of results of the form

$$R = \{ R_1, R_2, R_3, \ldots, R_m \}$$

where each R_i, $i \in \{ 1, 2, 3, \ldots m \}$ is an ordered n-tuple of the form

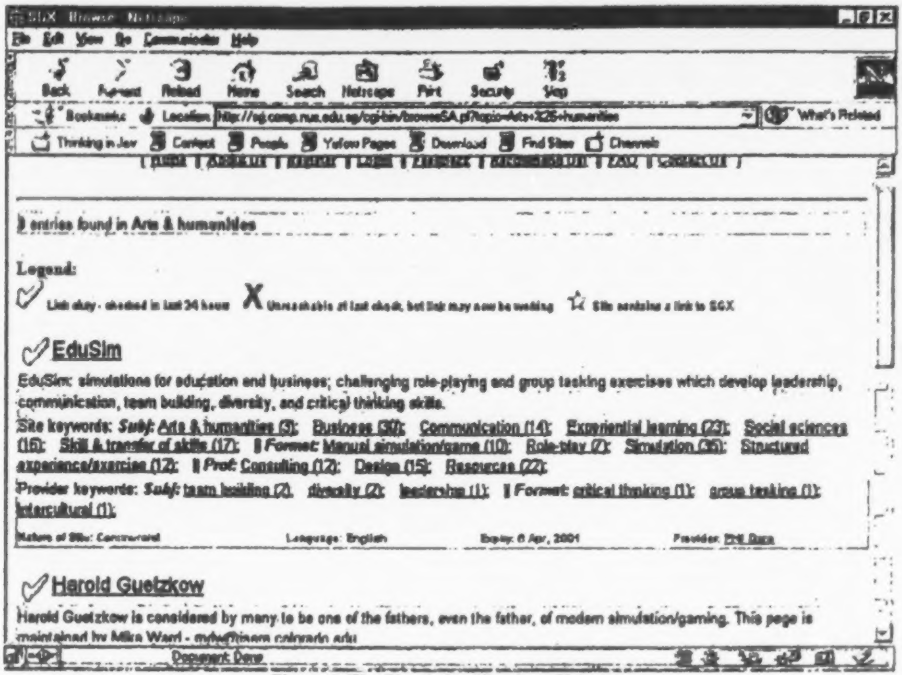
$$<V_1, V_2, V_3, \ldots V_n>$$

Each element in the set R is then mapped to the known Metadata Schema of DSIC Y, after which the results are formatted and displayed by DSIC X.

The above scenario can be extended to more than 2 DSICs by simply requesting metadata tuples from each DSIC in turn. In this way, the DSIC union can be regarded as a single, distributed service with multiple access points, providing high quality cross-domain information to learners seeking such information.

5 An Example

An example of a domain specific information clearinghouse is the Simulation/Gaming eXchange [6]. This is a clearinghouse for resources in the simulation and gaming domain. Most of the resources in the clearinghouse are submitted by domain experts and are of high quality. Some entries are submitted by the *SGX Information Agent*, a software agent which uses techniques found in [2] and [3] to scour the Web and retrieve resource related to those submitted by the domain experts. A typical entry in [6] is show in Figure 4.


SGX Browse - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print Security Stop
Bookmarks Location
What's Related
Thinking in Java Contact People Yellow Pages Download Find Sites Channels
Document: Done

http://sgi.comp.nus.edu.sg/cgi-bin/browseSA.pl?topic=Arts+%26+humanities

3 entries found in Arts & humanities

Legend:

✓ Link okay - checked in last 24 hours X Unreachable at last check, but link may now be working ☆ Site contains a link to SGX

✓ EduSim

EduSim: simulations for education and business; challenging role-playing and group tasking exercises which develop leadership, communication, team building, diversity, and critical thinking skills.

Site keywords: *Subj:* Arts & humanities (3); Business (30); Communication (14); Experiential learning (23); Social sciences (16); Skill & transfer of skills (17); | *Format:* Manual simulation/game (10); Role-play (7); Simulation (36); Structured experience/exercise (12); | *Prof:* Consulting (12); Design (15); Resources (22);

Provider keywords: *Subj:* team building (2); diversity (2); leadership (1); | *Format:* critical thinking (1); group tasking (1); intercultural (1);

Nature of Site: Commercial Language: English Expiry: 6 Apr, 2001 Provider:

✓ Harold Guetzkow

Harold Guetzkow is considered by many to be one of the fathers, even the father, of modern simulation/gaming. This page is

Figure 4: The Simulation/Gaming eXchange

Assuming that there is another information clearinghouse in the domain of CAI. This information clearinghouse also has its list of classifications and resources that have been submitted by experts. Upon registration into the union, the CAI clearinghouse will identify its relationship and links with the other clearinghouses that are already in the union. In this case, the CAI clearinghouse has to determine its relationship with the simulation/gaming domain. Some of the overlapping regions between CAI and simulation/gaming include edutainment, the use of simulations and virtual reality in learning. These resources can be applied to both the simulation/gaming domain and CAI domain when simulation/gaming is used as a tool in teaching using computers

Both CAI and simulation/gaming experts have submitted resources to their respective domain-specific information clearinghouses. Some of these resources are similar and will overlap each other. Using the overlapping regions as a starting point, the information agent in each clearinghouse will collaborate by sharing the resources they have. When a learner searches for virtual reality related resources in the CAI domain clearinghouse, he will be prompted that more resources are available in the simulation/gaming domain. He will also be linked and directed to these resources found in the simulation/gaming information domain. In this way, more resources can be retrieved without compromising on the quality of the results. This is very useful for learners with multiple domain interests. Furthermore, learners are also able to see how other domains relate to his domain interest. This sharing is done with the help of the union agent.

6 DSIC Toolkit

Although different domain specific information clearinghouses catalog resources in different domains, they have the same main functionality as follows:

- **Registration** – Users can register as information resource providers via online forms
- **Catalog** – Registered domain experts can login to the system and catalog resources. In addition, an automated information agent is used to gather resources from the Web automatically. Authors are identified by the agent and invited to refine the catalog of their own resources.
- **Browse** – Web users can browse through the resources cataloged in the clearinghouse using the classification scheme employed
- **Feedback** – A feedback mechanism must be provided for users to give feedback to the DSIC administrator
- **Administration** – An authorized administrator is allowed to make administrative changes to the system as an administrator

These similarities in different clearinghouses provide the foundation for the development of a generic, flexible toolkit for the rapid deployment of a domain-specific information clearinghouse. Domain experts with little or no Web development expertise but wish to deploy and maintain an information clearinghouse can make use of this toolkit to rapidly set up one.

The DSIC toolkit is designed as an integrated package with the following components:

- Web server
- Classification Scheme Editor
- HTML Template Editor
- Administration Module
- User Module
- Information Agent Module

A set of default templates are provided together with the toolkit so that a domain expert who wishes to set up a clearinghouse can selectively use the components of the toolkit and set it up in a short time span instead of having to start from scratch.

7 Conclusions

In this paper we have proposed a framework that allows learners to collaborate and share resources. With the use of domain specific information clearinghouses, learners are able to find useful, valuable and related resources. The clearinghouse union is a mechanism that allows different domains to come together and share their resources. This is especially useful for researchers and learners who have multiple domain interests. They are able to find resources across the different domains without compromising on the quality of the results.

Knowledge discovery and sharing is also made possible with the help of the union agent that overlooks all the domain clearinghouses in the union. The union agent not only helps learners retrieve related resources in other domains but also searches through the huge databank of resources to find hidden relationships about the different domains, giving us information on how different domains are linked and related to one another.

Finally, we also presented a clearinghouse toolkit currently under development for the rapid deployment of an information clearinghouse. Through the use of the toolkit, domain experts can quickly specify a classification scheme and set up a clearinghouse. The newly deployed clearinghouse is automatically registered with the union and start sharing resources with other clearinghouses already in the union.

References

[1] Loren T., Will H., and Brian A., "Constructing, Organizing, and Visualizing Collections of Topically Related Web Resources", in ACM Transactions on Computer-Human Interaction, Vol. 6(1), March 1999.

[2] Neri, F. and Saitta, L., "Machine Learning for Information Extraction", in Proceedings of the International Summer School on Information Extraction, SCIE '97 (Frascati, Italy, July 14-18, 1997.) Springer-Verlag Berlin Heidelberg, 1997, pp. 171 – 191.

[3] Theilmann, W. and Rothermel, K. "Domain Experts for Information Retrieval in the World Wide Web", in Proceedings of Second International Workshop on Cooperative Information Agents (Paris, France, July 4-7, 1998.) Springer-Verlag Berlin Heidelberg, 1998, pp. 216 – 227.

[4] Eric J.G., Steve L., William P. B. and C. Lee G., "Architecture of a Metasearch Engine that Supports User Information Needs", in Proceedings of CKIM 1999.

[5] http://www.usatoday.com/life/cyber/tech/review/crg842.htm

[6] http://sg.comp.nus.edu.sg

[7] http://www.w3.org/RDF

The Gathering and Filtering Agent of Education Newspaper for NIE

Chul-Hwan Lee, Sun-Gwan Han, Hee-Seop Han
Inchon National University of Education
Dept. of Computer Education
Tel +82-32-540-1284
#59-12 Geysan-dong Geyang-gu Inchon 407-753 Korea
chlee56@compedu.inue.ac.kr {fish,hansg}@compedu.inue.ac.kr

This paper presents the ENIG Agent to gather distributed information of educational newspaper in the web as well as student to provide the sound information for the NIE learning. The ENIG Agent gleans an appropriate newspaper headline of educational news portal site for real-time provision of the information. For gathering the optimized information, The ENIG agent performs the pre-process of educational news site, information noise filtering, pattern matching. The gathered educational newspaper information is removed a harmful data by using the pattern matching in the inference engine. The student can show the result of sound data through the web-browser as well as can use to learning with another application. For efficiency of this system, we evaluate the performance of the ENIG system by the experience of the NIE learning.

Keywords: **NIE, Newspaper Information gathering, Intelligent Agent, Supervised learning**

1 Introduction

These days, the web brings about a great change of education by a rapid growth of the Internet. It is not an easy work that a student finds the education information in the web. For searching the suitable information, a various search engines were developed and it provided a service for all. However, the general search engine is not fit that a student use at learning directly, because the information of search engine can contain a many data unconcerned learning. The learning requires the filtered information that can apply learning directly. Therefore, for efficient education, new type of search engine needs for the information retrieval and gathering [9].

Besides, the NIE means "Newspaper In Education", it is a method that student and teacher increases an efficiency of learning by using newspaper. The late web is used a good place for the NIE learning and a collaborative learning. However, when student and teacher study on the NIE learning through the web sites, they spend much time and repetitive efforts to find the newspaper contents. The student can lose a basic purpose of the NIE learning by the wasteful spending. The NIE learning needs an intelligent searching agent that searches automatically an important content about newspaper on the web. Moreover, because the gathered educational newspaper can contain harmful data, the data can remove by using the pattern matching in the inference engine [8].

Consequently, this paper describes about the ENIG Agent for the NIE learning. For providing the student just wants newspaper contents, we designed and implemented the intelligent agent system. In the following section, the NIE and the agent for information retrieval will be surveyed and the basic structure of the ENIG Agent will be designed. Furthermore, the next section will be discussed about implementation and experiment of ENIG Agent system. Finally the conclusion and future works will be described.

2 NIE and intelligent gathering agent

The NIE is the initials of 'Newspaper In Education'. It is the education method for individual who make friend with newspaper and improves the achievement of learning using the contents of newspaper. The newspaper, "a living text book", is applied with open education through the NIE learning.

Roles of newspaper for education are listed below [5].

- The newspaper is a bridge that can connect the disparity gap between school and society.
- The newspaper is the reflective of actual world.
- The newspaper reappears the scene of the history and is researching material of present society.
- The newspaper is the most suitable of clear text model and is used with subject matter of language learning.
- The newspaper is the unique textbook that everybody can read in ones lifetime continuously.

For the reasons stated above, we can expect a advantages that the NIE learning is originality, thinking power, ability to read and understanding and writing text, the establishment of sociality through ones sense of values, ability to practical use of information and so on[8].

When teacher will teach using NIE content on the web, we must consider below list.

- The newspaper is not be made data for the NIE. Because it is made for adult, it has a very difficult vocabulary. Therefore, teacher must supply to student a vocabulary database.
- The newspaper has an article about negative contents of society. Such contents must be edited or deleted by using an intelligent agent.
- Because the web is opened to everyone, the newspaper may have contents that student never see. In special, an article of obscene, crime, violence must be deleted.
- The contents of a newspaper are best the events of the day. But the NIE is used the contents of old newspaper. Such contents are good saving at scraping DB.

The method of information retrieval is variety. For information retrieval of educational homepage, intelligent agent used a very suitable tool [9]. The intelligent agents having the characteristics of autonomy, social ability, reactivity, pro-activeness and cooperative relationship can provide the searching results of a user demanded through machine learning [11].

An agent gathers information instead of the user. Because the agent system does not deal with basic data, instead it deals with knowledge information, can easily process the knowledge of education homepage. Moreover, an agent system is capable of using effectively gathering of information on the dynamic web environment. Therefore, the web based instruction using the NIE learning needs intelligent agent system [3].

3 ENIG System

Generally, the web document has many added tag information in contents. This added tag can represent efficiently information and data of HTML document. However, the user does not use the tag information but can use only the text or the multimedia information. The tag information treats only an unnecessary noise to users. If an unnecessary noise tag in a content is removed, the filtered document is translated a regular expression in the ENIG system. The pattern of information is extracted at transforming regular expression by the string matching method.

The extracting information of content is interpreted the accuracy of information by inference engine. Inference engine has the knowledge base augmented with a rule-based system, and it has function of learning and inference by a supervised learning.

3.1 Structure of the ENIG agent system

The structure of the ENIC Agent system is shown figure 1. This system consists of four parts. The document of homepage on web filters tags by the noise-filtering module in analyzer. The information of filtered document is translated from HTML document into regular expression. The regular document is matched with the string pattern provided by string matcher in an agent and it extracts the information of articles in educational newspaper. The information of an articles is removed harmful data by the knowledge base in an inference engine. The interface module consists of two screens. The rule and knowledge is edited and added, deleted through the knowledge manager and gathering information is supplied to student by using the result viewer. The learning environment is a learning space that studies the NIE learning through web browser and a learning application programs.

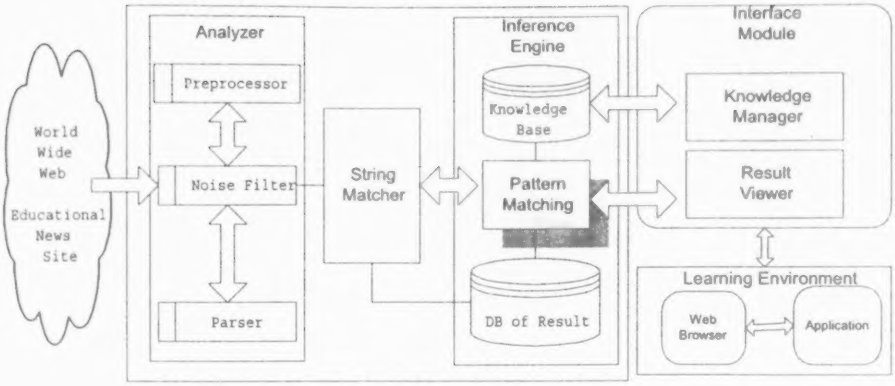

World
Wide
Web
Educational
News
Site
Analyzer
Preprocessor
Noise Filter
Parser
String
Matcher
Inference
Engine
Knowledge
Base
Pattern
Matching
DB of Result
Interface
Module
Knowledge
Manager
Result
Viewer
Learning Environment
Web
Browser
Application

Figure 1. Structure of ENIG Agent

3.2 Noise filtering

Figure 2. Homepage of educational newspaper

Figure 3. Source of homepage

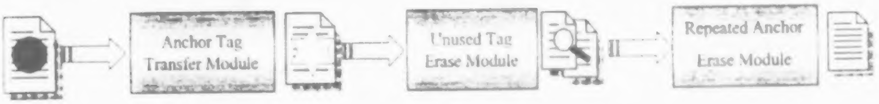

Anchor Tag
Transfer Module
Unused Tag
Erase Module
Repeated Anchor
Erase Module

Figure 4. Steps of noise filtering

The example of educational newspaper site is shown figure 2. The tag information is not shown to user on the web-browser. While, the source of newspaper homepage is shown figure 3. The source is represented with a text and a complex tag information. Such tag information represents the arrangement of a document data and a multimedia information, a hyperlinked information.

The noise filtering is used to remove duplication data or an unnecessary data. For processing data called by HTTP, the noise filter processes work that removes a useless portion of the input data. The tags of HTML document have an irrelevant information to user, because tags only represent the formation of homepage and information of hypertext.

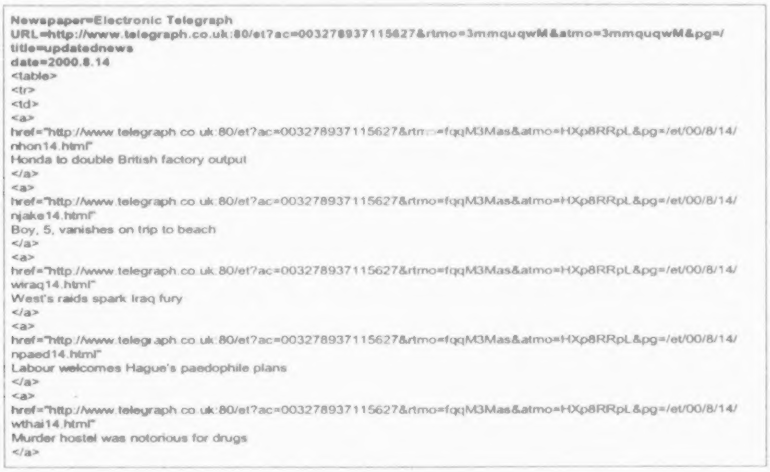
The noise filtering of the ENIG agent system removes an unnecessary tags in the document of an educational newspaper homepage except <A>...</A>tag, anchor tag of hyperlink and text data. The HTML sources are a difficult document to process noise filtering unconditionally, because the tag of document includes important information for the contents of document. Therefore, the noise filtering work must require a preprocessing module. Three steps of the noise filtering work is shown figure 4.

The preprocessing work for the noise filtering converts from basic <A>...</A> tag into suitable information and the works is listed below.

- Convert relative path for absolute path
- Change the URL of ASP form for the URL of HTML form
- Convert the path of CGI for general HTML form
- Change the path of script for absolute path
- Convert the hyperlink of image for absolute path

At the next step, the preprocessed documents are removed unnecessary tags by the noise filtering method except following items. <TABLE>,<TR>,<TD>,<LI>,<P>,<BR> tags are necessary the tags to keep the information of documents. The HTML document is composed one line of text or a record of table by such tags. Because most results of searching are represented with form of list or table, such tags is very an important information and may be not removed.

The final step of noise filtering is a work that gets rid of the duplicate from the URL of a document. The filtered document of educational newspaper homepage is show figure 5. We can know that the filtered document is ease for content analysis upon deletion of an unnecessary HTML tags. The advantage of noise filtering is that, it can process the same analysis about another newspaper homepages through removing tag.



```
Newspaper=Electronic Telegraph
URL=http://www.telegraph.co.uk:80/et?ac=003278937115627&rtmo=3mmquqwM&atmo=3mmquqwM&pg=/
title=updatednews
date=2000.8.14
<table>
<tr>
<td>
<a>
href="http://www.telegraph.co.uk:80/et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/
nhon14.html"
Honda to double British factory output
</a>
<a>
href="http://www.telegraph.co.uk:80/et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/
njake14.html"
Boy, 5, vanishes on trip to beach
</a>
<a>
href="http://www.telegraph.co.uk:80/et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/
wiraq14.html"
West's raids spark Iraq fury
</a>
<a>
href="http://www.telegraph.co.uk:80/et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/
npaed14.html"
Labour welcomes Hague's paedophile plans
</a>
<a>
href="http://www.telegraph.co.uk:80/et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/
wthai14.html"
Murder hostel was notorious for drugs
</a>
```

Figure 5 Result of a noise filtering

3.3 Pattern matching

The filtered document is translated from each information and data into regular expression. The pattern of regular documents is extracted with sequence of regular expression by the method of string matching. The hyperlink information of image may infer by using the pattern matching through regular expression, because the hyperlinked image do not contain the text information on hyperlink. The pattern matching is executed to extract text data and information of hyperlink in HTML documents. Specially, if image has been including hyperlink, the pattern matching is a very important work. The article information of the educational newspaper site has information of hyperlink as followed.

*< a href= ......> ...... text ......   *

Generally, the hyperlinked text information exists between <a> tag and tag. If an image exists between the anchor tags as " <img src=...> ", then text information can exist at front or back of the anchor tags. In this case, each tag and the text information is changed the defined tokens previously. In addition, each data is created a string of a regular expression by the pattern matching.

The portion of tokens for creation of regular expression is shown table 1.

Table 1 Token for regular expression

<table>	</table>	<p>	</p>	<tr>	</tr>	<td>	</td>	<a>		href	text
T	T	P	p	R	r	D	d	A	a	H	M

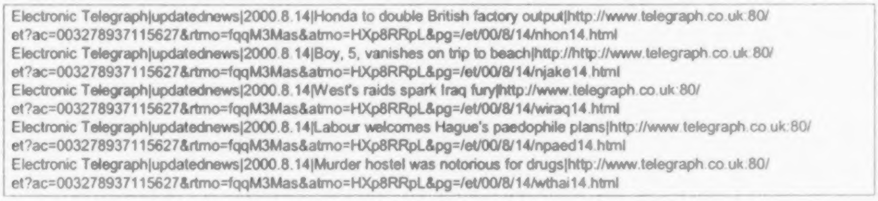
If the filtered document is represented with regular expression by tokens of table 1, the content of figure 5 is converted a tag page into the sequence of the alphabet as "TRDAHMaAHMaAHMaAHMa…". And the string pattern of regular expression has the process of pattern matching. This study used the three types of pattern for pattern matching as followed.

- *"AHMa" : "< a href= ……> …… text …… "*
- *"MAHa" : "... text ... <img src=...> "*
- *"AHaM" :" <img src=...> ... text ..."*

The extracted string by pattern matching restores to the original tag and text information in HTML document. The extraction strings are reverted with source records. Figure 6 shows result that article is extracted through pattern matching of regular expression.

The translation of regular expression and the pattern matching have a many advantages. The advantage of pattern matching method is that the complex matching of string can extract only one time by matching of substring, and that agent can easily learn the rule of pattern.

Therefore ENIG system eases the addition of new educational newspaper site and pattern by the addition of URL and the type of pattern.



```
Electronic Telegraph|updatednews|2000.8.14|Honda to double British factory output|http://www.telegraph.co.uk:80/
et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/nhon14.html
Electronic Telegraph|updatednews|2000.8.14|Boy, 5, vanishes on trip to beach|http://http://www.telegraph.co.uk:80/
et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/njake14.html
Electronic Telegraph|updatednews|2000.8.14|West's raids spark Iraq fury|http://www.telegraph.co.uk:80/
et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/wiraq14.html
Electronic Telegraph|updatednews|2000.8.14|Labour welcomes Hague's paedophile plans|http://www.telegraph.co.uk:80/
et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/npaed14.html
Electronic Telegraph|updatednews|2000.8.14|Murder hostel was notorious for drugs|http://www.telegraph.co.uk:80/
et?ac=003278937115627&rtmo=fqqM3Mas&atmo=HXp8RRpL&pg=/et/00/8/14/wthai14.html
```

Figure 6 Example of string exchanging for regular expression

3.4 Inference and learning method

The extracted newspaper information is not provided all good information to student. In case of an inserted advertisement site, such site can become an obstacle of learning by the useless content. Moreover, a negative content or a harmful page too must be not suitable site to student. Such sites can be provided about a lustful content and a crime, an slang, a violence and so on. The harmful data can be removed in advance learning by inference engine and knowledge base. Reasoning rule uses the rule-based production system. The representation of knowledge is shown below

IF A THEN B

The production system has a merit that it is simple and easy the representation of rule as well as the addition of knowledge. The learning method of the ENIG Agent system uses the supervised learning learned by human teacher. If new rule is occurred, teacher input new rule and knowledge in knowledge base. For example, if the extracted information contains harmful text as a sex and a narcotic, a knife, then teacher input new rule and knowledge as "*IF sex AND narcotic AND knife THEN delete*".

The harmful site at gathering site reason a rule by the analysis of content and the rule are stored in knowledge base by teacher. The bad information of extracted document is removed by the vocabulary DB and the rule of knowledge base. For forbidding the access of the student, the addition and deletion of rule and fact in the knowledge base can be control only by a teacher.

4 Implementation and Experiment

The implemented ENIG Agent can extract only the important information of newspaper site. In addition, it can be had with only a text and URL information at various homepage. For implementation of the ENIG Agent, we used Visual C++ and the CLIPS DLL. The CLIPS is rule-based a production system shell and it is used as an inference engine.

The execution screen of the ENIG agent system is shown figure 7. The ENIG system is composed of three parts. The left side of the screen is a part that the directory manager manages and edits educational newspaper sites, and the mid-screen is a part to view the result of the gathering information, and the button of right above is part to add a rule for inference and machine learning. If 'gathering' button is clicked, the ENIG agent gathers and extracts an article from an educational newspaper site. If 'learning' button is clicked, a rule and knowledge is added and edited by teacher in the ENIG agent.

This ENIG agent system can be applied directly at the homepage of different domain without change of system. If site is constructed standard HTML document, an agent can search and gather even the document of a foreign site.

The applying example of NIE learning using the ENIG system is shown figure 9. This example is used the ENIG system and the Web Browser and word processor. The screen is the NIE learning about music using the ENIG agent system and the Window application. The information of newspaper on the web can be applied directly at a web-based instruction (WBI).

One of the advantages of this system is that the extracted information uses a mobile environment directly. Because the extracted information is very small data and hyperlinked information, such data can be inserted the mobile communication as a cellular phone, a PDA, a notebook computer, a portal computer, and so on. Furthermore, the information of this system can transmit the WML by WAP.

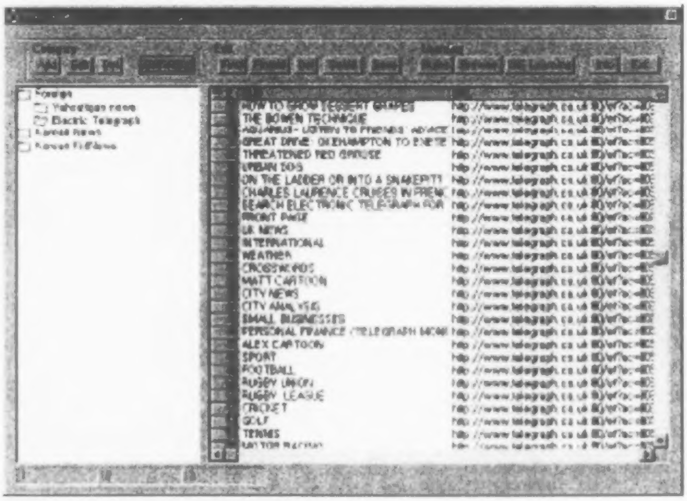
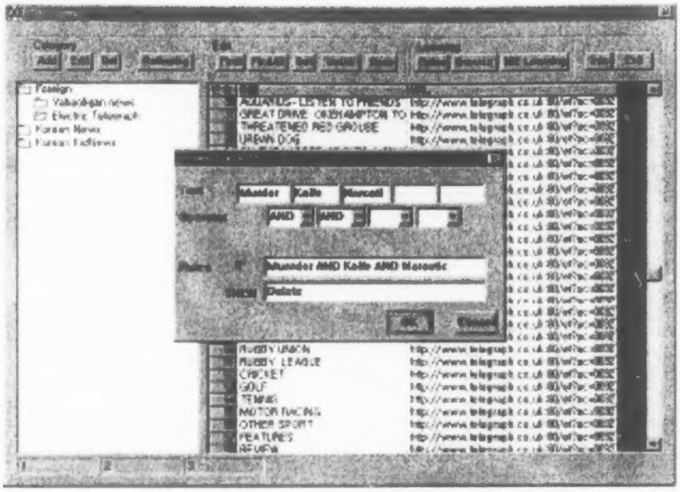
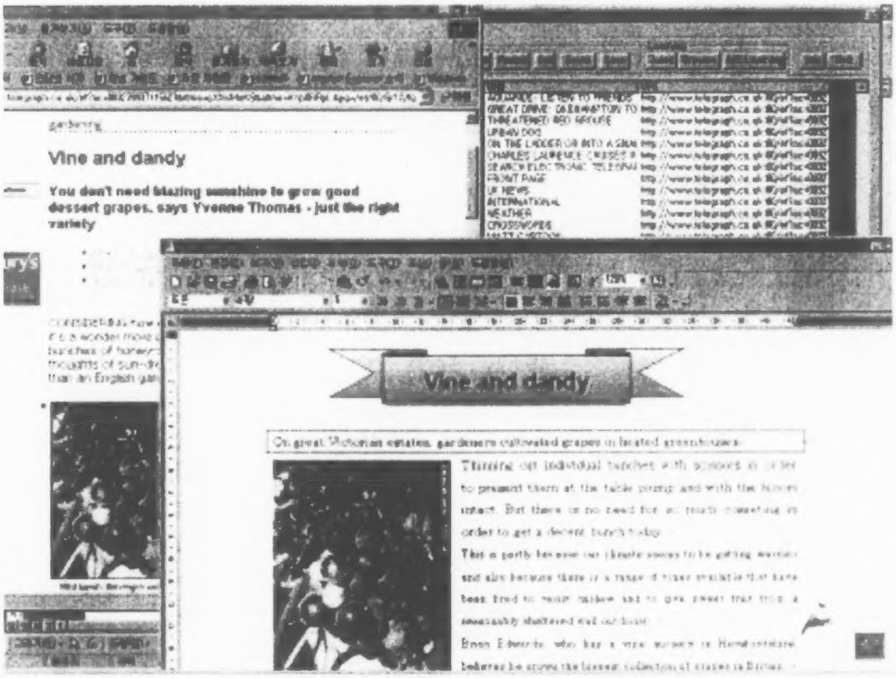


Figure 7 ENIG Agent system



GREAT DRIVE: OKEHAMPTON TO
THREATENED RED GROUSE
URBAN DOG
RUGBY UNION
RUGBY LEAGUE
CRICKET
GOLF
TENNIS
MOTOR RACING
OTHER SPORT
FEATURES
REVIEW

Figure 8 Addition of knowledge



Vine and dandy

You don't need blazing sunshine to grow good dessert grapes, says Yvonne Thomas - just the right variety

GREAT DRIVE: OKEHAMPTON TO
THREATENED RED GROUSE
URBAN DOG
FRONT PAGE
UK NEWS
INTERNATIONAL
WEATHER
CROSSWORDS

Figure 9 Example of NIE learning using ENIG agent

5 Conclusion and Future works

As mentioned above, we described about the ENIG agent system for the gathering information of educational newspaper homepage. In addition, we designed the method of noise filtering and pattern matching for suitable information. The method of noise filtering was used to remove unnecessary tags at source of HTML document and the method of pattern matching was used to extract necessary URL and text information. The learning of agent was used to provide with good information to student by supervised learning. Most a web-based instruction was mainly learning about information retrieval. As student spent a lot of time to find learning information and data, so these lead deficiency of time for the essential learning.

Consequently, the ENIG agent system can provide not only to student for the learning of information retrieval but also can help them capturing the genuine NIE learning. And this system can execute the role of information treasury for the whole education through scraps of information.

The future works are that we improve the faculty of agent for information gathering of all sites; moreover, we need research about unsupervised learning of agent and not supervised learning. In addition, we need research to remove gathering information of header and footer through addition of heuristics and pattern type that requires the study about the method of keyword searching it. Finally, for providing a location of information to the agent, we will research the extension method of URL.

References

[1] Barbara Hayes-Roth. "An Architecture for adaptive intelligent agent systems", Artificial Intelligent, Vol. 72, pp.329-365, 1995.

[2] David Pallmann, "Programming Bots, Spiders, and Intelligent Agents in Microsoft Visual C++", Microsoft Press,1999.

[3] Erik Selberg, Oren Etzioni, "Multi-Service Search and Comparison using the Metacrawler", Proceedings of the 4th World Wide Web Cinference, Boston, MA, USA, pp 195-208, 1995

[4] Filippo Menczer, Alvaro E. Monge, "Scalable Web Search by Adaptive Online Agents: An InfoSpiders Case Study", Intelligent Information agents, Springer, USA, pp 323-347, 1998.

[5] Frances Anderson, "Classroom Newspaper Activities: A Resource for Teachers, Grades 1-8", Charles C Thomas Pub, 1985

[6] Henry Lieberman, "Personal Assistants for the Web: An MIT Perspective", Springer, USA, pp 279-292, 1998.

[7] Josheph Giarratano, Gary Riley, "Expert System, Principles and Programming", PWS Publishing Company, 1994.

[8] Paul Sanderson, "Using Newspapers in the Classroom: Cambridge Handbooks for Language Teachers", Cambridge Univ. Press, 1999.

[9] Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval", Addison-Wesley, 1999.

[10] Sandip Sen and Gerhard Weiss, "Learning in Multiagent systems", The MIT Press, USA pp 259-298, 1999.

[11] Wooldridge, M., Jennings, N. R., "Intelligent Agents", Springer-Verlag, 1995.

Empowering Secondary School Teachers to Effectively Exploit Internet Resources for the Enhancement of Teaching and Learning

Y. T. Yu* and B. C. Chiu**
**Department of Computer Science, City University of Hong Kong, Tat Chee Avenue, Kowloon Tong, Hong Kong. Email: csytyu@cityu.edu.hk*
***Curriculum Development Institute, Education Department, HKSAR, 24 Tin Kwong Road, Kowloon, Hong Kong. Email: scdodp1@ed.gov.hk*

There are great potentials for the use of computers in the enhancement of teaching and learning in secondary schools, but in some subject areas, the realisation of these potentials is critically limited by the lack of appropriate educational software. Custom development of this kind of software is often not a viable alternative, since such a task is well known to be non-trivial and time-consuming that is frequently beyond the capacity of individual secondary school teachers. As computer science researchers and educators, we are aware that vast amount of teaching resources are freely available on the Internet. Such resources are often used by tertiary educators for enriching their teaching, but largely under-utilised by secondary school teachers. This paper reports our experience in the design and delivery of a short course which aims at refreshing practising secondary school computer teachers with updated knowledge on teaching and learning with computers. We describe how we achieve our goals of providing practical assistance to computer teachers by empowering them to effectively exploit Internet resources for use in their schools. Our approach is enabling in that it fosters participants' lifelong learning beyond the contents of the present course, and is applicable to a broader context than ours.

Keywords: **Teacher education, lifelong learning, program visualisation, algorithm animation**

1 Introduction

For a long time, educators and computer scientists have been exploring the use of computers in education [9]. The rapid drop in hardware price and the tremendous improvement in computing power in recent years have rendered computers more affordable to schools, teachers and students. Hardware is no longer the bottleneck that hinders the integration of information technology (IT) into the school curriculum. There are increasingly great potentials for using computers to enhance teaching and learning at all levels of education. In some subject areas, however, the realisation of these potentials is severely limited by the lack of appropriate educational software.

The development of good quality CAI software is well known to be a non-trivial and time-consuming task that calls for the combined expertise of programmers, experienced educators, graphics/multimedia designers, and others [10]. Such a task is often beyond the capacity of individual teachers in primary and secondary schools, due to their limited time, technical expertise and perhaps monetary resources. More fundamentally, it would not be realistic to require every teacher to develop their own CAI software from scratch for use. This is even true for most university educators. As Resmer [13] argues, "if every professor in a university had to write their own textbook, typeset it, print it, publish it, bind it, and distribute it before their students could use it, [textbooks] would not be a viable learning resource". Likewise, for widespread and effective use of computers in education, there is a need for teachers to be well informed of the source of available educational software.

The Internet promises to be a source of many valuable teaching resources that are frequently available freely or at affordable costs. There are many advantages of exploiting Internet resources for use in teaching. Apart from cost savings, software tools on the Internet are more likely to be kept up-to-date as technology advances, and their evaluation versions could be put to trial use before making actual purchases.

By nature of their work, many university educators are accustomed to the exploitation of Internet resources for both research and teaching purposes [14]. In contrast, these resources have largely been under-utilised by secondary school teachers due to various reasons. Firstly, many teachers are not aware of the existence of such resources on the Internet. One example is the use of visualisation and animation tools that are great aids to program understanding. Although the existence and effectiveness of these tools have been well known to computer science researchers in the field, our experience is that few secondary school teachers are aware of this.[1] Secondly, teachers might not know where these resources are, even if they are aware of their existence. Blind searches on the Internet are likely to be inefficient and sometimes not productive, in terms of the time taken to retrieve useful materials. Thirdly, the use of some resources requires a level of technical competence that a typical secondary school teacher might lack. Finally, some software tools have to be adapted to suit the needs of individual teachers, and without any support or assistance, such tasks could be daunting.

In this paper, we report our experience in the design and delivery of a short course which aims at refreshing practising secondary school computer teachers with updated knowledge on teaching and learning with computers. We describe how we achieve our goals of providing practical assistance to computer teachers by empowering them to effectively exploit Internet resources. Our approach is enabling in that it fosters participants' self and lifelong learning beyond the contents of the present course. We believe that our approach is actually applicable to a broader context than ours and therefore would be of interest not only to secondary school computer teachers, but also to teacher educators and teachers of other disciplines at all levels.

The rest of this paper is structured as follows. Section 2 introduces the context and goals of our short course. Section 3 provides the background of the subject area: computer programming and visualisation tools. Section 4 describes how we exploit Internet resources for use in the course. Section 5 describes the implementation of the course and the feedback from participants. Section 6 discusses our approach. Section 7 concludes this paper.

2 The Teachers Update Course

2.1 Background and objectives

Our university has been organising the Teachers Update Course (TUC) annually as a service to local secondary schools. It aims at refreshing practising school teachers with updated knowledge on the subject areas they teach, and offering advice and assistance on the teaching and learning of the subjects. It serves to show our university's concerns to secondary education, to share our professional expertise, and to promote communication and cooperation between our university and secondary schools.

TUC consists of a series of half-day short courses that encompass many subject areas such as Use of English, Mathematics, Computer Studies, Physics, and others. This paper reports our experience in the design and delivery of the course on Computer Studies. Participants of the course were mainly secondary school teachers of computer subjects such as Computer Studies and Computer Literacy.

2.2 The local secondary school context

In Hong Kong, school teachers are often heavily loaded with both teaching and non-teaching commitments. Typically, a teacher has to conduct six to seven lessons per day, each lesson lasting for 35-40 minutes. In

---

[1] One author of this paper previously taught a class of student teachers in a Postgraduate Certificate in Education programme who were major in Computer Studies, and none of them were aware of the existence of program visualisation and algorithm animation tools. Similarly, none of the practising computer teachers who participated in the Teachers Update Course described in this paper were aware of such tools.

addition to such work as lesson preparation, setting and marking tests and examinations, most teachers have to share school administrative work as well as leading students to participate in extra-curricular activities.
In recent years, the Government of the Hong Kong Special Administrative Region (HKSAR) has undertaken numerous initiatives to promote the integration of IT into the school curriculum [3]. Since teachers of computer subjects are usually more acquainted with the use of computers than other colleagues, they are often busily involved in the setting up and management of the IT infrastructure of their schools, and they are generally expected to assist other teachers in solving various problems in using IT.

Increasingly, there are pressures for teachers of all subjects to apply IT in their teaching activities. Many teachers have to spend a great deal of time after school hours to attend in-service IT training courses [8,9]. However, one common problem they encounter is the limited availability of appropriate educational software, and few of them have the time and expertise to develop their own courseware. Moreover, budgets are limited in schools for the purchase or development of courseware.

2.3 Goals and strategy

During the planning and preparation of the short course on Computer Studies, the following goals were formulated in an effort to maximise the usefulness of the course to the participants:

- *The course had to provide materials that are directly relevant to teaching in schools.*

  The course in the previous year was intended to broaden the computer knowledge of school teachers by providing updated information on multimedia and their applications. As such, the course was organised in the form of a condensed lecture of part of an undergraduate subject, supplemented by demonstrations of the applied research work of our staff in the area. Although the subject materials were interesting, many teachers subsequently indicated a preference of topics that are more directly related to their own teaching in schools. Simply acquiring further knowledge in the computing field was not as welcome as knowing something directly useful for solving the problems they encountered in their teaching.

- *The course had to offer practical assistance to teachers.*

  Considering the heavy workload of secondary school teachers, any teaching resources must be easy to use and demonstrably useful, or they would not be used at all. In selecting the course materials, preferences were given to those that are easily and practically applicable in the secondary school context. This strategy is also in response to the feedback by teachers in the previous year of their desire to learn something that is "more relevant [to their teaching]".

- *The course should motivate teachers' interests and empower them to pursue further via self-learning.*

  The course was a short one and naturally limited in the amount of teaching materials we could possibly provide. Even with a much longer duration, it would still be impossible to inform the teachers everything they had to know about the topic. Moreover, even for the same topic, there are considerable variations in their needs (for example, due to different teaching styles or their students' background). The same technique useful to one teacher might not work for another. What is more important is to foster their ability to pursue the topics further beyond what we offer, whenever they have the need to do so. Therefore, from the outset the course was designed to "have an empowering or enabling effect on the participants" [9]. We hoped that the course could enable school teachers to acquire what they need via self and lifelong learning.

Setting the right goals was important, but the real challenge was how to achieve these goals within a few hours of contact with the participants. We now outline our strategy as follows. Firstly, we selected a topic that would likely interest most computer teachers: computer programming and algorithms. This topic is clearly directly related to their teaching. Secondly, we collected useful information and software tools for the enhancement of teaching and learning of this topic. Most of these resources were originated from overseas and would be hard to access were they not put on the Internet. Thirdly, among them, we selected only those information and software tools that were judged to be practically useful in the local secondary school context. Finally, we demonstrated to teachers how they could have found and utilised these resources on their own through the Internet.

In retrospect, we believe that although the first step (topic selection) is important in ensuring the relevance of the course, it is our approach in the remaining steps (use of the Internet resources) that would have more profound influence to the participants. Our approach will be discussed in detail in Section 6. Meanwhile, we briefly introduce the subject area in Section 3 and then elaborate on what we did in the course in Sections 4 and 5.

3 Computer programming and visualisation tools

3.1 Computer programming as a common major part of many computing curricula

Computer programming and algorithms is usually considered a significant and fundamental component in undergraduate computer science education [6]. In most universities, introductory programming and the design of elementary algorithms are the first courses that a computing major undergraduate student has to take (unless these courses were exempted due to credit transfer or advanced standing). Elementary programming courses are also frequently offered as electives to non-computing students with a broad variety of backgrounds [10].

At the secondary school level, computer programming is historically the major component of a typical computer subject. Although the emphasis of learning programming has now been reduced as compared to the past, there is, arguably, still a place for it to be included in the secondary school curriculum. In Hong Kong, both the Computer Literacy subject (offered to almost all junior secondary students) and the Computer Studies subjects (offered as electives to senior secondary students) include programming as a major part of the curriculum [2].

3.2 Difficulties of teaching and learning computer programming and algorithms

The teaching of computer programming and algorithms presents a great challenge to educators at both the secondary level and the tertiary level [15]. To understand a computer program or an algorithm, the student needs to have a good understanding of the internal execution model of computers, as well as the dynamics of variables, data structures and control flows in the algorithm [7]. Such concepts are abstract in nature and could be difficult to even novice programmers [16], let alone non-computing major undergraduates and secondary school students. Indeed, according to our survey to secondary school teacher participants of our short course, about 82% of the respondents agreed that computer programming and algorithms are the hardest topics to teach.

There is usually considerable overlap between the contents of a computer subject in a secondary school and those of a first year course on computer programming in a university. As such, the difficulties encountered by secondary school teachers are in many ways similar to those faced by the professors in universities, as far as the teaching of basic computer programming and elementary algorithms is concerned.

Nevertheless, usually only the academically more capable students will enter universities. As a whole, the secondary school student population is less mature in intellectual development and more diverse in their academic ability. Compared with university students, many of the secondary school students tend to be less motivated and less capable of independent learning; they normally require more guidance in their studies.

Secondary school teachers are generally less well informed and possess far less resource under their disposal than university educators. To our knowledge, a great deal of research has been done in many universities to address the difficulties in learning computer programming and algorithms [1,5,6,7,12,15]. Unlike universities, however, secondary schools seldom have the resources and expertise to perform similar work to solve their problems. In fact, they might not be aware of such research activities. Our approach in the course is to facilitate the use of university resources on the Internet by secondary school teachers to solve their own problems.

3.3 Program visualisation and algorithm animation

Program visualisation refers to the use of graphical artifacts to represent both the static and dynamic aspects of a program [11]. Algorithm animation portrays the dynamics of the execution of an algorithm by means of animation tools [7]. Educators and researchers have long believed that visualisation and animation are useful in helping students understand the abstract concepts and dynamics involved in computer programming and algorithms [15]. It is believed that visualisation and animation tools help the learners by displaying in concrete form the mental model of the execution of computer programs Indeed, many universities worldwide have been actively researching and experimenting with the use of visualisation and animation tools. As a result, a variety of such tools have been developed for different purposes [1,5,6,7,12,15]. Many experimental results have been reported that favour the use of such tools for enhancing program understanding [6,7,15].

4 Exploiting Internet resources for useful educational software tools

Despite years of active research, program visualisation and animation tools are still not widely used in secondary schools, and few such tools designed for teaching and learning are available commercially.[2] As discussed in Section 2.2, it is often impractical for secondary schools to develop their own tools.

As computer science researchers and educators, we are aware that many program visualisation and algorithm animation tools have been developed as results of research work in various universities. Even though some tools have been developed mainly for demonstrating the research ideas and therefore might not have as many features as commercial software, most have been designed for teaching and learning. More importantly, they are usually available for free and easy access through the Internet for educational purposes. To our judgment, there are great potentials of utilising such tools in enhancing teaching and learning in secondary schools.

The idea of utilising research tools on the Internet for enhancing secondary school education is obviously appealing and has many advantages over acquiring similar tools by other means. We shall discuss these further in Section 6. However, before being convinced of the practicality of this idea, we had two concerns. Firstly, although these tools had been successfully applied in the tertiary education context, would they be useful in secondary schools as well? Secondly, would secondary school teachers be competent enough to make use of these tools that have originally been designed for use by tertiary educators who are technically more proficient?

To develop this idea further, we set out to evaluate the practicality of using Internet resources as teaching and learning aids in secondary schools. As program visualisation and algorithm animation do not fall into our own research areas, we started our search from only the scarce information that we had. Beginning with the Web sites of two well known researchers in these areas that we incidentally came across and made note of a few years ago, we followed links over links, and so on. It turned out that there was little difficulty in the search of relevant Internet resources. The more tedious and time-consuming task was to evaluate the contents of these resources one by one. Even so, within a few weeks' time, we were amazed to have collected and evaluated almost a hundred sites of related interest! These resources range from the innovative use of common spreadsheet software by researchers in the University of Helsinki [12], to ambitious laboratory projects such as the DYNALAB project of Montana State University [1], and university students' research projects such as Jeliot [5].

We selected and evaluated the resources according to several criteria: (1) relevance in content and level to the syllabus of secondary school computer subjects, (2) accessibility, (3) flexibility (customisability), (4) software and hardware requirements, (5) difficulty in technical content, (6) ease of setup and customisation. After evaluation, we decided to recommend about 30 web sites. The contents of these web sites range from ready-made animations of common algorithms, to downloadable program visualisation tools that support both forward and backward execution [1], and even online animation of user-defined algorithms using customisable 'actors' in a 'theatre-like environment' [5].

Through the process of selection and evaluation, we are increasingly convinced of the practicality of our approach. Many of the tools we found could be effectively used by people with some elementary knowledge of computer programming and concepts of program visualisation. Our participants were computer teachers who clearly possess knowledge of the former but not necessarily the latter. Therefore, part of our short course was to explain the program visualisation concepts and how they could be useful to aid program understanding.

---

[2] Although most commercial program development environments do provide some limited facilities such as the display of the contents of variables during program execution, these are primarily designed to aid software development (particularly to aid debugging) by programmers. These facilities are not targeted to beginner learners and usually not well suited for the purpose of teaching and learning.

5 Course implementation and feedback

Our course began with discussions on the common problems in developing CAI software. Then we introduced various sources from which useful CAI software could be obtained freely or at nominal costs for topics in computer subjects in general. These sources included higher educational institutions, students pursuing higher education, professional educational bodies, textbook publishers and others. The use of these Internet resources was more straightforward and requires no further elaboration other than the provision of pointers.

Next, we introduced the concept of utilising program visualisation techniques for the enhancement of teaching and learning, and the corresponding selected Internet resources. For ready made animation tools that were straightforward to use, we simply provided pointers and made two representative demonstrations, leaving the participants to try and pursue the tools at their own pace after the course.

A few selected tools, however, were introduced in much more detail. These tools have one or more of the following characteristics: (1) they were technically more advanced; (2) they could be used in several ways to suit different educational purposes; (3) they had features that were particularly useful or illuminating; (4) their designs were based on notions that were innovative and less obvious to understand but practically very useful. Fortunately, the participants were mainly computer teachers whom could be safely assumed to possess the necessary programming skills and concepts to perform the required customisations. Were we to simply show the links of these resources, it could be difficult for them to tap the potential benefits of these tools effectively.

The participants were so interested in the selected Internet resources that the course was substantially overrun. At the end of the course, participants were requested to complete a questionnaire about their background (for planning of future courses) and about how well they felt the course had been organised (for evaluation of the present course). Some of the statistics obtained are as follows:

1. About 82% of the respondents agreed that computer programming and algorithms are the hardest topics to teach.
2. About 90% of the respondents agreed (with 26% strongly agreed) to the statement that "I will try to make use of the course materials at school when appropriate". None disagreed; the rest were undecided.
3. About 87% of the respondents agreed that the course was useful to them; none disagreed and the rest were neutral. The same number of respondents agreed that they were satisfied with the course. Some felt that the course could have been improved by extending the duration to allow more time for further discussions.
4. All respondents agreed that the demonstration of the Internet resources for teaching was the most useful part in the course.

6 Summary and discussions

6.1 Characteristics of our approach

We began with the ideas that program visualisation tools are useful for learning computer programming, but such tools are not widely known, of limited availability and hard to develop by secondary school teachers themselves. Yet Internet resources abound that could be effectively exploited for use in secondary schools. As researchers in the university, by nature of our work we are usually better informed with the availability of such resources and the advancement of the latest technologies. In planning and designing the short update course for teachers, we positioned ourselves as mentors in the search of relevant teaching resources. We aimed at offering practical assistance to secondary school teachers by providing the source of relevant information on the Internet, by demonstrating the potential benefits of utilising such information, and by guiding them through the solutions to the technical problems that might arise in utilising such information. We attempted to motivate the interests of participants, to help them overcome the initial barriers (that is, to make "jump start") so that they could eventually help themselves exploit the vast potentials of Internet resources via self and lifelong learning. Incidentally, in so doing, we have exemplified our course as an alternative model of "teaching in the information age" in which teachers serve more like a mentor than an authoritative knowledge provider.

Our approach is characterised in several ways which distinguish it from that of a traditional teacher education course. Firstly, our goal was modest yet pragmatic in trying to address a specific but real problem that a typical secondary school computer teacher encounters daily: the difficulties of teaching computer programming. Secondly, we demonstrated to the participants how Internet resources could be effectively and practically utilised for addressing their problems. What is even more distinctive is the recommended use of tools developed by researchers with the latest software technologies of the field for use in tertiary education. We have argued that both tertiary educators and secondary school teachers share many common problems that call for similar solutions. Secondary school teachers could learn a great deal from the experience of educators in universities when dealing with their common problems. Finally, the course was designed to be enabling and empowering, with the explicit a priori goal that participants could pursue the subject further via self and lifelong learning.

6.2 Reflections and discussions

On completion of the course with encouraging feedback from the participants, we reflect on the factors contributing to our success. We note that a key factor is our decision to take advantages of the use of selected Internet resources, especially those from universities worldwide. Firstly, these resources are easily *accessible* to teachers and students alike, as long as they are connected to the Internet. The ease of access also minimises the problems that might occur in the distribution and installation of custom developed or commercial software. Moreover, the use of educational tools on the Internet is *cost-effective*. Many of these tools have been demonstrated to be effective through their use in universities. They are typically designed by computer scientists for demonstrating the advantages of applying their research ideas in education, and have subsequently been experimented and evaluated for continuous enhancements, with such evaluations adequately documented in their research papers. More importantly, they are available freely or at affordable costs. Cost is often a critical factor determining whether an educational software tool will be widely used in secondary schools, as resources at their disposal are usually fairly limited.

Some of the software tools we recommended were developed as prototypes with source codes publicly available [12]. They are usually based on sound theoretical principles and accompanied by technical or educational papers describing the theory and implementation in detail. Teachers may customise these tools to suit their specific needs that might vary due to differences in teaching styles, objectives, and students' backgrounds. They may choose to use the whole or part of the tool, or write small program components to be integrated with these tools. For computer teachers who are acquainted with and probably interested in writing programs, such "lightweight customisation" is usually easier and more feasible than building a complete CAI system from scratch. Customisation by users is not normally adequately supported by commercial software that comes with no source code and only limited documentation such as operational guides.

Technologies and knowledge have been advancing very rapidly. On the Internet, new resources keep emerging as results of continuous research by academics who explore the latest technologies for the enhancement of teaching and learning. An example is the experimentation of using 3D visualisation, multimedia and virtual reality technologies in education as they emerge [4]. Teachers who are well informed of such activities through self-learning on the Internet will be in a better position to make use of the latest research results and technologies for continuous improvements to their teaching and learning in ways that are not otherwise possible.

The use of research tools for teaching and learning is not without problems. However, most of these problems would not be deterrent; they could be solved or avoided. Other problems are present in the use of other sources of educational software anyway. For instance, research tools are often imperfect, with some functionality not fully implemented; but as long as the implemented features are considered useful, the tools can be used in part rather than in full. There might be a lack of instant technical support, but many researchers who develop the prototypes are keen to collect feedback, as these might be crucial for their continuous research work. Inevitably, frequent revisions might occur to these tools for research purposes, but if the teacher finds an earlier version useful, that version could be downloaded and kept for use instead of relying on its availability at the source.

7 Conclusions

University educators possess the necessary resources, expertise and freedom to fulfil their roles of performing experimentation and researches, and producing prototypes to demonstrate the usefulness of their innovative ideas. In comparison, secondary school teachers are too occupied with teaching activities and other professional commitments. Most teachers cannot afford the purchase of expensive commercial software for teaching, nor do they generally have the capacity of developing appropriate educational software on their own. Success of integrating IT in the school curriculum is critically determined by the availability of easy-to-use and adaptable tools that satisfy the diverse needs of teachers and students of a variety of backgrounds in different contexts.

The Internet has provided a medium on which tertiary educators can make their resources and experience publicly available to be shared by all, including secondary school teachers. Around the world, numerous tertiary educators have gladly done so as part of their service to the community. Unfortunately, such resources are largely under-utilised by secondary school teachers, due to reasons such as the lack of knowledge and technical competence. For computer teachers, these barriers are relatively easy to overcome, as long as appropriate support and assistance is provided. For teachers of other disciplines, more help might be required. Ultimately, secondary school teachers have to learn, adapt and use these resources by themselves, and to keep themselves updated via self and lifelong learning to respond to the rapid changes that the world has been undergoing.

In this paper, we have reported our experience in the design and delivery of a short course that has progressed towards this direction. Our course also exemplifies itself as one possible model of "teaching" as "facilitating the self and lifelong learning of the participants". Most tertiary educators have now become regular users of Internet resources for enhancing their teaching and learning. It should not be long before secondary school teachers have to follow suit. What we have contributed is but a small part of the continuing collaborative effort to empower teachers to use IT effectively in secondary schools, and ultimately to better education of our younger generations.

References

[1] Boroni, C. M., Eneboe, T. J., Goosey, F. W., Ross, J. A. and Ross R. J. (1996). "Dancing with DynaLab – Endearing the science of computing to students". In *Proceedings of the Twenty-Seventh SIGCSE Technical Symposium on Computers Science Education (SIGCSE' 96)*, 135-139, Philadelphia, USA, February 1996.

[2] Curriculum Development Council (1993). *Syllabuses for Secondary Schools, Computer Studies (Secondary 4-5)*, Hong Kong Government Press.

[3] Education Manpower Bureau (1998). *Information Technology for Learning in a New Era: Five-year Strategy 1998/99 to 2002/03*. November 1998, HKSAR.

[4] Gloor, P. A. (1998). "Animated algorithms". In Stasko, J., Domingue, J., Brown, M. H. and Price, B. A. (eds), *Software Visualization: Programming as a Multimedia Experience*, MIT Press, Cambridge, MA.

[5] Haajanen, J., Pesonius, M., Sutinen, E., Tarhio, J., Terasvirta, T. and Vanninen, P. (1997). "Animation of user algorithms on the Web". In *Proceedings of IEEE Symposium on Visual Languages (VL' 97)*, 361-367, Isle of Capri, Italy, September 1997.

[6] Kalayar, M., Ikematsu, H., Hirashima, T. and Takeuchi, A. (1999). "Intelligent learning support system for algorithm learning". In *Proceedings of 7th International Conference on Computers in Education (ICCE' 99)*, **2**: 840-843, Chiba, Japan, November 1999.

[7] Kann, C. and Lindeman, R. W. (1997). "Integrating algorithm animation into a learning environment". *Computers and Education*, **28**(4): 223-228.

[8] Kong, S.-C., Au, W.-K. and Pun, S.-W. (1999). "A case study on the implementation of information technology education pilot scheme in Hong Kong". In *Proceedings of 7th International Conference on Computers in Education (ICCE' 99)*, **2**: 27-34, Chiba, Japan, November 1999.

[9] Law, N., Wan, J., Lau, M. F., Lee, R. and Yuen, A. H. K. (1999). "Towards a model of IT training for inservice teachers". In *Proceedings of 7th International Conference on Computers in Education (ICCE' 99)*, **2**: 51-58, Chiba, Japan, November 1999.

[10] Mulholland, P. and Eisenstadt, M. (1998). "Using software to teach computer programming: Past, present and future". In Stasko, J., Domingue, J., Brown, M. H. and Price, B. A. (editors), *Software Visualization: Programming as a Multimedia Experience*, MIT Press, Cambridge, MA.

[11] Price, B.A., Baecker, R.M., and Small, I.S. (1993). "A principal taxonomy of software visualisation". *Journal of Visual Languages and Computing*, **4**(3): 211-266.

[12] Rautama, E., Sutinen, E. and Tarhio, J. (1997). "Excel as an algorithm animation environment". In *Proceedings of Annual Joint Conference Integrating Technology into Computer Science Education (ITiCSE' 97)*, 24-26, Uppsala, June 1997.

[13] Resmer, M. (1999). "IMS – Distributed learning standards". In *Proceedings of 7th International Conference on Computers in Education (ICCE' 99)*, **2**: 567-570, Chiba, Japan, November 1999.

[14] Sloane, A. (1997). "Learning with the Web: Experience of using the World Wide Web in a learning environment". *Computers and Education*, **28**(4): 207-212.

[15] Stasko, J. and Lawrence, A. (1998). "Empirically assessing algorithm animations as learning aids". In Stasko, J., Domingue, J., Brown, M. H. and Price, B. A. (editors), *Software Visualization: Programming as a Multimedia Experience*, MIT Press, Cambridge, MA.

[16] Yu, Y. T. and Poon, P. L. (2000). "An approach for evaluating the quality of software developed by novice programmers". In *Proceedings of the 4th World Multiconference on Systemics, Cybernetics and Informatics (SCI' 2000) and the 6th International Conference on Information Systems Analysis and Synthesis (ISAS' 2000)*, **2**: 485-490, Florida, USA, July 2000.

Examining Problems of Student Teachers to Build a Web-supported Environment

Shihkuan Hsu* and Hsiou-huai Wang**
Center for Teacher Education, National Taiwan University
1, Sec. 4, Roosevelt Road, Taipei, Taiwan 10617
**Tel: +886-2-23692364 ext. 214*
E-mail:skhsu@ccms.ntu.edu.tw
***Tel: +886-2-23692364 ext. 215*
E-mail:wanghs@ccms.ntu.edu.tw

Student teaching is an important part of teacher training programs. With the emerging and the widespread use of the Internet, it is important to consider how this crucial stage of teacher development can be facilitated by the use of the technology. In order to create for a user-oriented and research-based web environment, this project was designed to explore problems that student teachers experience. During the internship year, student teachers filled out a self-report critical problem questionnaire five times in two periods, one in each semester. The student teachers were asked to pick one critical problem that they had tried hardest to solve in the day or the week. In the survey, they wrote down the ways to solve the problem as well as the resources they used in the process. The results showed that peer student teachers were those whose help were mostly sought. Over 90% of the means to solve the problem was face-to-face. It is summarized that student teachers may need three types of proximity for problems: Professional, emotional and physical. To provide rich interpretation to the problems, it is suggested that an experience database with focused case study discussion forum may be of help to student teachers' problems.

Keywords: **Student teacher, Student attitude, Teaching experience, Internet use**

1 Introduction

Student teachers are in the process of becoming a teacher. Fresh from the university, student teachers are often full of ideals and enthusiasm. Entering the real world of teaching, however, they are likely to experience problems and difficulties that can be termed "reality shocks" (Wubbels, Creton, Hooymayers & Holvast, 1982). With the Internet technology becoming more accessible and versatile, there are an increasing number of web-based projects to assist student teachers (Georgi & Crowe, 1998). Instead of building the technology first and assessing the student teachers later, this project intends to design a research-based and student teacher-oriented web environment.

This study proposes to examine the needs of the student teachers and use the results as basis to construct a web environment. During a one-year internship, a class of 76 student teachers were asked to participate in the survey and interviews for their problems and difficulties, as well as the resources they used to resolve their problems. The analysis of the problems will be used to develop the guidelines and the structure of the website.

2 Theoretical Background

2.1 The problems of the student teachers

Numerous studies have been done to understand the problems and "reality shocks" that student teachers encountered. In an extensive review, Veenman's (1984) collected 91 research studies in the last two decades.

His summary of the findings suggested eight categories of problems, including managing student, motivating students, dealing with individual differences, evaluating students' work, communicating with parents, organizing class work, obtaining supply and teaching material, and tackling individual student's problems. Chen & Chen (1999) critiqued the previous researcher-designed surveys and used student teacher's journals as a means to understand their problems. They collected 800 student teachers' journals and used Multidimensional Scaling to analyze the data. The major categories of student teacher's reality shock included status uncertainly, students' attitudes and disciplines, conflicts between the decision maker and the doer, the negative-reinforcement style of management, the working ethics of teacher and staff, as well as the relationships among school members (Chen & Chen, 1999).

While many studies addressed the problems that student teachers encounter, most of them focused on why the problems occurred and how to solve the problems for them. Very few, on the contrary, investigated how student teachers solved their problems. Questions regarding whom student teachers asked for help and what resources they used in solving their problems were seldom discussed. The purpose of study, therefore, is not to postulate another possible cause of the problems, rather, is to find out what resources student teachers use to solve their problems, and how technology can help expand this access.

2.2 The problems with the technology

The use of Internet technology for teacher training has received growing attention. E-mail is perhaps still the most widely used means to encourage communication between the supervising teacher and student teachers (Nabors, 1999). More recent developments include more sophisticated design such as electronic portfolio to promote reflection and performance-based assessment (Georgi & Crowe, 1998). Morley's (1999) project uses WebCT, an Internet-based interface, for course syllabus, class notes, hyperlinks, as well as bulletin boards for faculty and students in pre-service method courses. The National Science Council in Taiwan in recent years has funded several projects in building web-supported environment student teachers in areas such biology, math, science and technology (Guo, 1999).

When new technology is added to student teaching, however, some precautions are warranted. As an add-on, the help it provides may not be critical to the user's needs nor adopted by the user in a long run. Examples can be observed in many websites where only few messages are found in the discussion area. As Hsu & Bruce (1998) observed, teachers in distance education often fail to communicate with their distance students because their pedagogical strategy with the new technology does not supply the necessary cues that is acquainted by the students in their face-to-face environment. Therefore in this project we want to explore student teachers' current situation before designing the website.

3 Methods

A total of 35 student teachers from 11 subject areas of junior and high schools participated in this one-year study. The participants were all recent graduates from university or graduate schools of the same university. To sample the student teacher's experiences with problems and difficulties across the internship year, the critical problem survey involved two rounds of sampling periods, once in the end of the fall semester and once at the end of the spring semester.

During the first semester, student teachers were asked to fill out a questionnaire once a week for five weeks. Every week they had to pick one most critical problem in the past week. Three open-ended questions were designed to elicit the most critical problem that demanded the most of the student teachers' time and energy to solve. The three open-ended questions were: 1) What is the most critical problem you have experienced during the week? 2) How do you resolve the problem? And what resources do you use? 3) At the end of the week, was the problem resolved? If not, how would you like it to be solved?

In addition to the open-ended questions, there was a chart where student teachers had to check boxes for the people they had talked to regarding to the problems they were trying to resolve. The choices included the cooperating teacher, the supervising teacher, the student teachers in the same subject area and different subject area from the same university, the student teachers in the same school but from different university, the family, the roommate, none, and others. They were also asked how many times they have made the contact and by what means the communication was made. The choices included face-to-face, phone, e-mail, and others.

The questionnaires were first mailed out to the student teachers. After the initial data collection, it was found that the returned rate was too low. Therefore, additional short telephone interviews with 25 students were arranged. The interview also provided a little more in-depth background for their problems and difficulties. At the end of the spring semester, the same questionnaire was filled out daily for five days with the help of telephone interviews. Regular attendance to the student teacher's monthly meeting and small group discussions also informed the interpretation of the data collected.

4 Results

4.1 Student teacher's problems

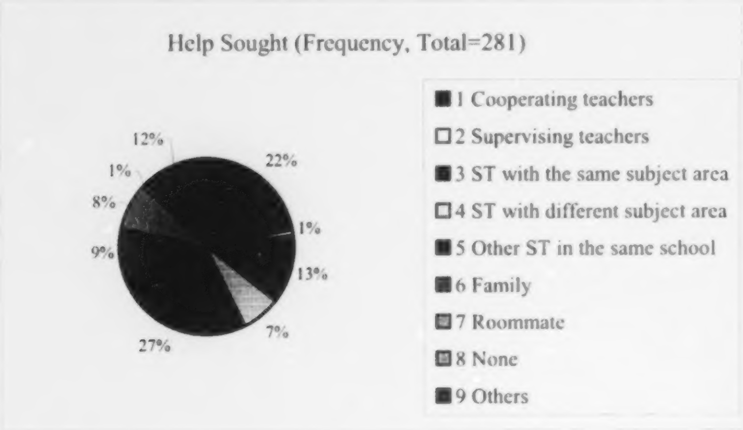
The results of the self-reported questionnaire and the transcript of the interview were coded by two researchers and two research assistants. The coding scheme originally used was Chen & Chen's (1999) findings of six categories, but the emerging themes of the data yields to the following four major categories in student teachers' problems. 1) Ambiguity of the status, including conflicts with the cooperating teachers for competing authority in the class; conflicts with school administrators in terms of task assignment; and conflicts with the school culture in terms of the feeling of unfit to the school physical environment, goals, and life styles. 2) Lack of professional knowledge, including subject knowledge, teaching skills, class management skills, and skills for student discipline problems. 3) Relationship with cooperating teachers, administrators, and students; including problems in making their needs known; and in dealing with small groups and gender issues. 4) Confusion in teaching as career goals, including conflicts between the ideal and reality.

4.2 Ways to solve the problems

When stressed by a problem, student teachers did not always know how to solve it. They usually consulted people for solutions. Categories of people whose help were sought after were coded from both the questionnaire and the interview. 1) Cooperating teachers, to ask for assistance or professional suggestions on classroom management and teaching skills. 2) Other teachers of the same subject area, for content knowledge and student discipline problems. 3) Other student teachers, to seek answers and condolence from others about conflict with the cooperating teacher and students' disciplines; also for relationship and cultural adjustment. 4) Solving the problem by oneself, such as trying out ones' own new ideas, making more effort to learn new things, adjusting attitude, accepting the reality, or simply enduring it.

Depending on the nature of the problem, other resources were sought for specific information. For legal issues, for example, some student teachers sought help from higher up authorities. In terms of technology, a few student teachers used the Internet to find teaching material and lesson plans. Not every problem had a solution, however. During our talk during the interview and in informal settings, quite a few students indicated that they often choose to passively accept the situation or to give up thinking for solutions. The following figure is a summary of the results from the questionnaire about the help the student teachers sought (see Figure 1). The results showed that about 47% of talks were with the other student teachers, where 27% were from the student teachers in the same school. About 22% of help was received from the cooperating teacher, and another 17 % were from family and roommate. Only 1% was from their supervising teachers. Among all the communication means, 92% were face-to-face, 6% were by phone, and 2% were by e-mail.

Figure 1 People whose help student teachers sought from



5 Discussion

According to the analysis, the problems of student teachers ranged from personal to professional. The solutions, although ranged from professional guidance to personal camaraderie, are limited to face-to-face communication. To contemplate what will help student teachers in solving their problems, it may be useful to postulate what they needs are. 1) Professional proximity. Being a novice, a student teacher may eager to know how others would have done differently. Those who are authoritative in professional fields, such as cooperating teachers, are likely to be pursued for instructional and managerial guidances. 2) Emotional proximity. Besides professional guidances, student teachers need to find emotional support to feel that they were not alone. It is also safer to talk to peers for issues of role adjustment and interpersonal relationships in schools. 3) Physical proximity. Those who are physically close (66%) are more readily to help. Therefore, when physical gatherings are not available, the help seeking channels can become seriously impeded.

Based on the above findings, we can begin to think about the design of a web-supported environment. The employment of a student teacher website should have features that provide additional or alternative support that take the above three types of proximity into account. The complexity of the problems and the limited access to solutions suggested that a case method that the user can criss-cross for multiple interpretations may be appropriate for learning in a complex knowledge domain (Spiro & Jehng, 1990). The following components are proposed in the website to be built. 1) A student-teaching case database. To provide experiences of other student teachers in a form of journals, including description of and reflection on various aspects of student teaching. This database is both outlined and keyword searchable. Hyperlinks to other similar cases can be also built. Student teachers can access to a peer's life lessons without having to have an appointment with him. 2) Guidelines and suggestions. Also included in the database are written guidelines and suggestions from academics, experts, experienced teachers and student teachers on the same topics as the above case database. Links to other web resources regarding professional information will also be added. Student teachers can reach specific information for guidance without much effort. 3) Focused case study discussion forum. To provide threaded bulletin boards on selected cases from the database. With shield identity, student teachers can find emotional support without being exposed. The cases can be rotated on weekly bases and among different subject matters. 4) Annotated video components of teaching. Also included in the database can be video clips of exemplar teaching of cooperating teachers as well student teachers' teaching. Written comments can be added by both the cooperating teachers and supervising teachers. This is a good place to engage a productive conversation among the triad of the student teacher, the cooperating teacher, and the supervising teacher.

It is hoped that with the aid of the technological power, the student teachers will have better chances to solve their problems and they should feel more empowered in their first full-time exposure to the real world of teaching.

References

[1] Chen, F. C. & Chen, H. L., "The experience of probation teacher's reality shock--The first season analysis." Proceedings of the Conference on the Exemplar and Practice of Educational Internship. Taipei, Taiwan, April 30-May 1, pp. 51-74, (1999).

[2] Georgi, D. & Crowe, J., "Digital Portfolios: A Confluence of Portfolio Assessment and Technology." Teacher Education Quarterly, Vol. 25, No. 1, pp. 73-84, (1998).

[3] Guo, Y. W., "Planning and promotion of the research on improving the science teacher quality." National Science Council Monthly, Vol. 27, No. 8, pp. 866-880, (1999).

[4] Hsu, S. & Bruce, B., "The missing borders: Pedagogical reflections from distance education." Teaching Education, Vol. 10, No. 1, pp. 47-54, (1998).

[5] Morley, L., "Expanding preservice teachers' tools for effective teaching." Paper presented at the Annual Conference on Technology in PE and Sport. Chattanooga, TN, USA, July, (1999).

[6] Nabors, M. L., "New functions for "Old Macs": Providing immediate feedback for student teachers through technology." International Journal of Instructional Media, Vol. 26, No.1, pp. 105-107, (1999).

[7] Spiro, R. J. & Jehng, J. C., "Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter." In D. Nix & R. Spiro (Eds.), Cognition, education, multimedia. NJ: Lawrence Erlbaum Associates, (1990).

[8] Veenman, S., "Perceived problems of beginning teachers." Review of Educational Research, Vol. 54, No. 2, pp. 143-178, (1984).

[9] Wubbels, Th., Creton, H. A., Hooymayers, H. P., & Holvast, A. J. C. D., "Training teachers to cope with the 'reality shock'." Studies in Science Education, Vol. 9, pp. 147-160, (1982).

Factors in Web-based learning: Student learning styles, motivation, learning strategies, and achievement

Ching-Chun Shih
Iowa State University
E016 Lagomarcino Hall
Ames, IA 50011
Tel: +1-515-294-1941
Fax: +1-515-294-9284
Email: ccshih@iastate.edu

This study analyzed the relationships between student achievement and the following variables: learning styles, motivation, learning strategies, and selected demographics. It was a population study that included 99 students taking two non-major introductory biology courses offered over the Internet by one Land Grant University in U.S. in the fall of 1997. Seventy-four (75%) students completed a learning style test, an on-line questionnaire, and received a grade by the end of the semester. The learning style test was the Group Embedded Figure Test (GEFT), which classified students as either field-dependent or field-independent. The on-line questionnaire consisted of two scales (motivation and learning strategies), whose pilot-test reliabilities were .70 and .79, respectively. Over two-thirds of the students taking the Web-based courses were field-independent learners; however, there were no significant differences (.05 level) in achievement by learning style. Also, different backgrounds of students with different learning styles learned equally well in Web-based courses. The students were motivated by competition and high expectations. They used most the learning strategies of finding important ideas from lectures and memorizing key words of important concepts. Motivation and use of learning strategies were the two significant factors that explained more than one-third of student achievement measured by class grade.

Keywords: **Web- based learning, learning styles, motivation, learning strategies, and achievement**

1 Introduction/Theoretical Framework

As the popularity of the WWW increases, its use as a means of delivering instruction is also growing. Alexander (1998) indicated, "the greatest potential of the Web, however, lies in the fact that we have a chance to learn from the lessons of the previous faded technologies, and an opportunity to develop new learning experiences for students that have not been possible before" (p.3). Furthermore, Parson (1998) and Alexander (1998) argued that while implementing a new technology, educators should evaluate how students learn via the new technology so as to help with curriculum and instructional designs. Parson (1998) added that it is important to understand how the new technology can affect learning when it is used by different types of learners.

Identifying students' learning styles helps educators understand how people perceive and process information in different ways. According to Cano, Garton, and Raven (1992), one of the most widely studied learning style theories contrasts field-dependence and field-independence. The Group Embedded Figure Test (GEFT), a standardized cognitive test, can be administered to determine the preferred learning styles of the learners as either field-dependent or field-independent (Oltman, Raskin, & Witkin, 1971). Literature (Witkin, Moore, Goodenough, & Cox, 1977; Raven, Cano, Garton, & Shellhamer, 1993; Miller, 1997) on learning styles suggests that field-dependent learners tend to approach a problem in a more global way, are socially oriented, prefer collaboration, and are extrinsically motivated. In contrast, field-independent learners tend to approach a problem more analytically, rely on self-structured situations, prefer competition, and are intrinsically motivated. According to Garger and Guild (1984), both field-dependent and field-independent people make equally good learners.

Like the literature on learning styles, the literature on learning strategies explores different ways of learning. However, in assuming stability as well as lack of individual control, learning style literature suggests that it may be difficult for students to change their learning styles (Pintrich & Johnson, 1990), whereas learning strategy literature assumes that students' motivation and use of learning strategies can be controlled by learners and changed through teaching. According to Cross and Steadman (1996), learning strategies are methods learners can use to improve their understanding, integration, and retention of new information. Learning strategies include a wide variety of cognitive processes and behavioral skills (Weinstein & Meyer, 1991). General learning strategy components include rehearsal, elaboration, organization, comprehension, metacognition, and resource management (Weinstein & Meyer, 1991; Cross & Steadman, 1996).

Pintrich and his colleagues developed a learning strategy instrument, *Motivation Strategies for Learning Questionnaire (MSLQ)* (Pintrich, Smith, Garcia & McKeachie, 1991). This instrument includes two main sections: one on motivation and one on learning strategies. The learning strategies section consists of two components (cognitive and metacognitive strategies, and resource management strategies) and eight scales, which are rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, and help seeking (Pintrich, Smith, Garcia & McKeachie, 1991).

The other section of the *MSLQ* is on motivation, which consists of three general components (value, expectancy, and affective) and six scales (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety). Several researchers (Pintrich, 1995; Pintrich & Schunk, 1996; Garcia, 1995; Bandura, 1986; Zimmerman, 1989) believed that students may use different motivational strategies in different learning situations and that students are able to learn to become self-regulated learners.

Motivation was found to be the best predictor of student achievement in the two studies that investigated factors influencing student achievement and effects of the factors on students' achievement in learning the Japanese language through the medium of satellite television (Oxford, Park-Oh, Ito, & Sumrall, 1993a; 1993b). It was also found that gender and learning styles played potentially important roles although they were not significant factors. Moreover, in the study on predicting student success with the learning and study strategies inventory, Hendrickson (1997) found that motivation was one of the best predictors of student grade point average.

Moreover, Curry (1990) used the concepts of motivation, learning styles, student achievement to explain the process of learning. Learning styles consist of a combination of motivation, engagement, and cognitive processing habits, which then influence the use of metacognitve learning strategies such as situation analysis, self-pacing, and self-evaluation to produce a learning outcome. Curry's taxonomy (1990) seemed to suggest that motivation, learning styles, learning strategies, and student achievement are associated.

Based on the previous literature review, student learning styles, motivation, and learning strategies seem to be associated with achievement. Research is needed to understand student motivation and learning strategies with different learning styles via WWW. Also, research is needed to obtain more understanding of the learning factors that influence student success in Web-based learning. This type of research will assist educators in planning, organizing, and delivering quality Web-based instruction in a manner that will improve student learning.

2 Purpose and Objectives

This study was a formative evaluation designed to enhance teaching and learning. Its purpose was to study how students with different styles learned in Web-based courses that were offered through Project BIO by Iowa State University, and to determine what factors influenced their learning. The objectives of the study were to identify: (a) the demographic characteristics of the students in relation to learning styles; (b) how students' motivation and learning strategies differed by their learning styles; and (c) relationships among student learning styles, motivation, learning strategies, demographics, and achievement.

3 Methods and Procedures

The population for this study included 99 students taking the two non-major introductory courses, Zoology 155 and Biology 109, offered through Project BIO by Iowa State University in the fall of 1997. These two Web-based courses developed by Project BIO were stand-alone courses in which most course materials and resources were accessed and delivered by the Internet (Parson, 1998). More than 60% (60) of the population were on-campus students and almost 40% (39) were off-campus students. Thirty-two out of the 39 off-campus students were high school students. Before the study was conducted, a letter was sent to the high school teachers to seek permission for their students to participate in this study.

The Group Embedded Figures Test (GEFT) was used to determine preferred learning styles, either as field-dependent (FD) or field-independent (FI). Individuals scoring greater than the national mean (11.4) were classified as field-independent learners, whereas those scoring less than the national mean were considered to prefer a field-dependent style. The total possible raw score on the GEFT was 18. The reliability coefficient for the GEFT was .82 (Witkin, Oltman, Raskin, & Karp, 1971).

An on-line questionnaire was designed by the researchers and included two scales plus demographic questions. The questionnaire, written in HTML (HyperText Markup Language) format, was posted on the web. Nine statements representing the motivation scale and thirteen statements representing the learning strategy scale were selected from the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991). The students were asked to rate themselves according to how well the motivation and learning strategy statements described them while they were taking the Web-based course by using a five-point scale with response options ranging from (1) Not at all typical of me to (5) Very much typical of me. Demographic variables included gender, Web-based courses they were taking, whether or not they were university students, types of students as off-campus, on-campus, or adult students, limited or unlimited access to a computer, number of courses previously taken in the subject area, and study and work hours per week.

Content and face validity for the questionnaire were established by a panel of three faculty members associated with Project BIO and three graduate students in Agricultural Education. The 5-point scales were pilot-tested for reliability with 38 students taking a different undergraduate Project BIO Web-based course, Biology 201. Cronbach's alpha coefficients were .71 and .80 for the motivation, and learning strategy scales, respectively. When a post-hoc reliability analysis was performed, the reliabilities for the two scales were .70 and .79 respectively.

The researchers administered the learning style test (GEFT) to on-campus students and proctors administered it to off-campus students. A total of 78 (79%) students completed the GEFT. The on-line questionnaire was posted on the web three weeks before the final exams. A follow-up electronic letter to nonrespondents of the on-line questionnaire yielded a total of 94 responses for a 95% return rate. For purposes of analysis, the learning style scores, questionnaire responses, and students' grades, which were provided by the instructors at the end of the semester, were matched. This yielded a final response rate of 74 (75%), which was considered to be an acceptable representation of the population. Data were analyzed using the Statistical Package for Social Science, Personal Computer Version (SPSSx/PC). Analyses of data included frequencies, means, standard deviations, t-tests, Pearson correlations, and multiple linear regression. The alpha level was established *a priori* at the .05 level.

4 Results

4.1 Objective 1: Demographic characteristics of the students in relation to learning styles

The usable responses included 29 (39%) in the Zoology class and 45 (61%) in the Biology class. Less than half (29; 39%) of the usable respondents were males. Twenty-eight (38%) were high school students and forty-six (62%) were university students. More than two thirds (51; 69%) of the respondents were field-independent learners. On average, the students had previously taken 1.45 courses in the subject areas of Zoology or Biology. The students spent an average of 4.55 hours per week studying, ranging from 1 to 20 hours and worked on an average of 16.97 hours per week, ranging from 0 to 80 hours. No significant differences by learning styles were found in the number of courses taken previously, study hours per week, or work hours per week.

While comparing respondents' learning style scores by gender, it was found that the male learning style mean score (mean = 14.07) was significantly higher than the female mean score (mean = 11.76). The learning style mean score of all respondents was 12.66. This was consistent with the preliminary norms data on GEFT, in which college men (mean = 12.00) performed slightly but significantly higher than college women (mean = 10.8) (Witkin, Oltman, Raskin, & Karp, 1971). However, in this study, the GEFT mean scores of both males and females were higher than those of the norm data (mean = 11.4).

4.2 Objective 2: How students' motivation and learning strategies differed by their learning styles

Although field-independent students had a mean of 3.51 and field-dependent students had a mean of 3.42 on motivation scale, no significant difference was found on student motivation by learning style (Table 1). The mean scores on the nine items ranged from 2.81 to 4.21. Four statements were rated above 3.50. The highest rated motivation was that the students wanted to get better grades than most other students (mean = 4.21). The second most highly rated item was that they expected to do well in the class (mean = 3.77). They also believed that they could do better if they studied in appropriate ways (mean = 3.70), and they preferred course material that aroused their curiosity (mean = 3.66). Only one statement, "I think of how poorly I am doing," was rated below 3.00. The overall mean for student motivation in Web-based learning was 3.48 with a standard deviation of .52.

Field-dependent students (mean = 3.27) had almost the same mean on the learning strategy scale as did field-independent students (mean = 3.25), and no significant difference was found in the t-test when comparing the overall use of learning strategies by learning style (Table 2). Moreover, four mean scores of the thirteen learning strategy items were rated above 3.50. The highest-used learning strategy was to find the most important ideas from lectures (mean = 3.85). The second most highly used strategy was to memorize key words of important concepts (mean = 3.76). The third most highly used strategy was to relate concepts to what they already know (mean = 3.70). The next most highly used strategy was to determine the concepts they did not understand well (mean = 3.68). The two lowest used strategies had mean scores under 2.50. They were "to give up the difficult parts and study the easy" (mean = 2.16) and "make charts or tables to organize the material" (mean = 2.14). The overall mean score for students' use of learning strategies was 3.25 with a standard deviation of .51.

Table 1. Means, Standard Deviations, and t-test for Respondents' Motivation by Field-Dependent (FD) or Field-Independent (FI) Learning Style (n = 74)

		Learning Style		
	Total	**FD**	**FI**	
Statements	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**t-value**
I want to get better grades than other students	4.21 (1.01)	4.26 (.96)	4.18 (1.04)	
I expect to do well in this class	3.77 (.84)	3.78 (1.00)	3.76 (.76)	
Studying appropriately, I can learn the material	3.70 (.89)	3.43 (.84)	3.82 (.89)	
I prefer course material that arouses my curiosity	3.66 (.80)	3.48 (.67)	3.75 (.84)	
I am satisfied with trying to understand content	3.49 (.80)	3.48 (.67)	3.49 (.86)	
Course material is useful to learn	3.49 (.83)	3.52 (.85)	3.47 (.83)	
I think of the questions I cannot answer[a]	3.30 (1.08)	3.30 (1.15)	3.29 (1.01)	
I am interested in the content area of this course	3.14 (.93)	3.00 (.95)	3.20 (.92)	
I think of how poorly I am doing[a]	2.81 (1.51)	2.83 (1.67)	2.78 (1.35)	
Total	**3.48** **(.52)**	**3.43** **(.57)**	**3.51** **(.50)**	**-.64**

Note: Scale 1=Not at all typical of me, 2=Not very typical of me, 3=Somewhat typical of me, 4=Quite typical of me, and 5=Very much typical of me.

[a] Negatively stated items. Means of these statements were reversed in the total mean

4.3 Objective 3: Relationships among student learning styles, motivation, learning strategies, demographics, and achievement

A hierarchical regression analysis was conducted to ascertain the amount of variance in students' standardized achievement scores by the variables of interest (Table 3). The three main learning factors of this study, learning styles, motivation, and learning strategies were entered into the regression model. The dependent variable was student standardized achievement. Student motivation was loaded first and explained 28% of the variance in their standardized achievement scores. Use of learning strategies was entered next into the regression. This variable explained additional 7% of the variance in student achievement. Then the learning style variable was entered into the regression model, and it explained an additional 1% of the variance in student achievement. Motivation (t=3.19) and use of learning strategies (t=2.98) were the two significant variables for the explanation of variance in achievement scores. The results from the analysis revealed that a total of 35% of the variance in student achievement was accounted by a combination of two significant variables, motivation and use of learning strategies.

Table 2. Means, Standard Deviations, and t-test for Respondents' Use of Learning Strategies by Field-Dependent (FD) or Field-Independent (FI) Learning Style (n = 74)

		Learning Style		
	Total	**FD**	**FI**	
Statements	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**t-value**
Try to find most important ideas from lectures	3.85 (.82)	3.87 (.92)	3.34 (.78)	
Memorize key words of important concepts	3.76 (.86)	3.78 (.85)	3.75 (.87)	
Try to relate to what I already know	3.70 (.92)	3.74 (.92)	3.69 (.93)	
Determine concepts I don' t understand well	3.68 (.85)	3.65 (.88)	3.69 (.84)	
Connect the readings and concepts	3.47 (.88)	3.65 (.98)	3.39 (.83)	
Read notes and readings over and over again	3.08 (1.12)	3.43 (1.20)	2.92 (1.06)	
Relate my ideas to what I am learning	2.99 (1.04)	2.74 (.92)	3.10 (1.08)	
Decide what I am supposed to learn from topics	2.93 (.93)	2.96 (.93)	2.92 (.93)	
Make good use of my study time	2.84 (.91)	2.87 (1.06)	2.82 (.84)	
Think of possible alternatives for conclusions	2.81 (.90)	2.61 (1.03)	2.90 (.83)	
Rarely find time to review notes or readings for tests[a]	2.79 (1.22)	2.65 (1.47)	2.86 (1.11)	
Give up the difficult parts and study the easy ones[a]	2.16 (.76)	2.26 (.75)	2.11 (.77)	
Make charts or tables to organize the material	2.14 (1.10)	2.09 (1.20)	2.16 (1.07)	
Total Mean	**3.25** **(.51)**	**3.27** **(.64)**	**3.25** **(.45)**	.17

Note: Scale 1=Not at all typical of me, 2=Not very typical of me, 3=Somewhat typical of me, 4=Quite typical of me, and 5=Very much typical of me.

[a] Negatively stated items. Means of these statements were reversed in the total mean.

Table 3. Hierarchical Entry Regression of Selected Variables on Standardized Achievement (n = 74)

Variables	**R^2**	**R^2 Change**	**B**	**t-value**
Overall motivation mean score	.28	.00	.68	3.19*
Overall learning strategies mean score	.35	.07	.65	2.98*
GEFT (learning style) score	.36	.01	0.03	.95
(Constant)			-4.70	-6.12*

Standard Error = .81, Adjusted R^2 = .34

F for the Model = 13.26 $p < .05$ (df 3, 70)

*$p < .05$

5 Conclusions/Recommendations

Males were more likely to be field-independent students, although the female scores on the GEFT also fell into the field-independent range. More field-independent students took the Web-based Zoology and Biology courses than did field-dependent students. This was similar to Miller's finding (1997) that the distant learners were relatively more field-independent than the norm groups.

Student learning styles and student characteristics--gender, Web-based courses they were taking, whether or not they were university students, types of students as off-campus, on-campus, or adult students, limited or unlimited access to a computer, number of courses previously taken in the same subject area, study and work hours/week--were not related to their Web -Based learning achievement. Moreover, field-independent students did not differ from field-dependent students in their motivation, learning strategies, and achievement in Web-based courses. The researcher concluded that students with different learning styles and backgrounds learned equally well in Web-based courses. And learning styles did not affect student motivation and use of learning strategies.

Students were undecided about their motivation and the use of learning strategies in Web-based courses. Getting better grades than other students and expecting to do well were the two most highly rated motivators for Web-based learning. Moreover, trying to find the most important ideas from lectures and memorizing key words of important concepts were the two most highly used learning strategies. These two learning strategies fell into the rehearsal and elaboration components of learning strategies in the MSLQ (Pintrich, Smith, Garcia & McKeachie, 1991). Students used least the learning strategy of making charts or tables to organize the material. In conclusion, students were motivated by competition and high expectations and used more rehearsal and elaboration learning strategies in Web-based learning.

Educators should provide students with information and opportunities to maintain healthy student competition and high expectations in Web-based learning, such as announcing mean scores of class tests for comparison and setting clear expectations for assignments and tests. Likewise, educators should understand student motivational factors so that they can stimulate student motivation and get students actively involved in the learning process. Additionally, educators should provide students with learning opportunities by using a variety of learning strategies to assure students' understanding, integration, and retention of course concepts.

Motivation and learning strategies seemed to be the most important factors in Web-based learning and accounted for more than one-third of student achievement. Student motivation and use of learning strategies by the students correlated significantly with student achievement. The higher the student scored on motivation and a general use of learning strategies, the higher the student's overall achievement in the class.

Motivational and learning strategies are crucial aspects of self-regulated learning. Self-regulated learning involves use of motivational and learning strategies to the degree that students are motivationally, metacognitively, and behaviorally active participants in their own learning processes (Zimmerman, 1989; Pintrich, 1995). This study found that motivation and learning strategies play important roles in Web-based learning, and this could be an effective support of self-regulated learning.

Further study is needed to identify motivation and use of learning strategies between high achieving and low achieving students in Web-based courses. Are the most highly used motivation and learning strategies used by the higher achieving students? Additionally, the cause and effect of use of motivational and learning strategies (self-regulated learning) should be investigated in the future studies.

References

[1] Alexander, S., "Teaching and learning on the World Wide Web," http://www.scu.edu.au/ausweb95/papers/education2/alexander/ (accessed August, 1998).

[2] Cano, J., Garton, B. L., & Raven, M. R., "The relationship between learning and teaching styles of student performance in a method of teaching agriculture course," Journal of Agricultural Education, Vol. 33, No. 3, pp. 8-15, (1992).

[3] Curry, L., "Learning styles in secondary schools: A review of instruments and implications for their use," ERIC Document Reproduction Service No. D 317 283, (1990).

[4] Cross, R. C., & Steadman, M. H., "Classroom research: Implementing the scholarship of teaching," San Francisco: Jossey-Bass Publishers, (1996).

[5] Garcia, T., "The role of motivational strategies in self-regulated learning," Understanding self-regulated learning, New directions for teaching, (1995).

[6] Garger, S. & Guild, P., "Learning styles: The crucial differences," Curriculum Review, Vol. 23, No. 1, pp. 9-12, (1984).

[7] Hendrickson, A. B., "Predicting student success with the Learning And Study Strategies Inventory (LASSI)," Unpublished master' s thesis, Iowa State University, Ames, (1997).

[8] Miller, G., " Are distance education programs more acceptable to field-independent learners?" ERIC Document Reproduction Service No. 409854, (1997).

[9] Oltman, P.K., Raskin, E., & Witkin, H.A., "Group Embedded Figures Test," Consulting Psychologists Press: Palo Alto, CA, (1971).

[10] Oxford, R., Park-Oh, Y., Ito, S., & Sumrall, M., "Japanese by satellite: Effects of motivation, language learning styles and strategies, gender, course level, and previous language learning experience on Japanese language achievement," Foreign Language Annals, Vol. 26, No. 3, pp. 358-371, (1993a).

[11] Oxford, R., Park-Oh, Y., Ito, S., & Sumrall, M., "Learning a language by satellite television: What influences student achievement?" System, Vol. 21, No. 1, pp. 31-48, (1993b).

[12] Parson, R., "An investigation into instruction available on the World Wide Web," http://www.oise.utoronto.ca/~rparson/abstract.html, (accessed August, 1998).

[13] Pintrich, P.R., "Understanding self-regulated learning," Understanding self-regulated learning, New directions for teaching and learning, No. 63, pp. 3-12, (1995).

[14] Pintrich, P. R., & Johnson, G. R., "Assessing and improving students' learning strategies," The changing face of college teaching, New Directions for Teaching and Learning, No. 42, pp. 83-92, (1990).

[15] Pintrich, P. R. & Schunk, D. H., " Motivation in education: Theory, research, and application," Englewood Cliffs, NJ: Prentice-Hall Inc., (1996).

[16] Pintrich, R., Smith, D. A. F., Garcia, T., & McKeachie, W. J., "Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ)," Educational and Psychological Measurement, Vol. 53, pp. 801-813, (1991).

[17] Raven, M. R., Cano, J., Garton, B. L., & Shellhamer, V., "A comparison of learning styles, teaching styles, and personality styles of preservice Montana and Ohio Agricultural Teachers," Journal of Agricultural Education, Vol. 31, No. 1, pp. 40-50, (1993).

[18] Weinstein, C. E. & Meyer, D. K., "Cognitive learning strategies and college teaching, College teaching: from theory to practice, New directions for teaching and learning, No 45, pp.15-26, (1991).

[19] Witkin, H.A., Oltman, P.K., Raskin, E., & Karp, S.A., "Group Embedded Figures Test manual," Palo Alto, CA: Consulting Psychologists Press, (1971).

[20] Witkin, H. A., Moore, C.A., Goodenough, D. R. & Cox, P.W., "Field-dependent and field-independent cognitive styles and their educational implications," Review of Educational Research, Vol. 47, No. 1, pp. 1-64, (1977).

[21] Zimmerman, B.J., "A social cognitive view of self-regulated academic learning," Journal of Educational Psychology, Vol. 81, No. 3, pp. 329-339, (1989).

Gold Peach Web Community 2000: A Research on Developing Web-Based Interactive Learning Environment

Wu, Tung-Xiung*; Yui-Liang Chen**
Dept. of Information Management, Shih Hsin University
#1, lane 17, Mu-Cha Rd. Sect. 1, Taipei, 116, Taiwan, ROC
**Email: txwu@cc.shu.edu.tw*
***Email: ychen@cc.shu.edu.tw*

This series research was based on the progressive concepts of web community, cultural and cultivation features to develop an interactive learning environment for children. The series was conducted from 1996 to 2000. There were four generations of web-human interaction and user interface has been developed and tested. There were four functions in this community: total Web-Based CAI, interactive learning navigation, collaborative learning classroom, and community management.

Keywords: **Web-Based Learning, Interactive Learning Environments, Web Community, Culture and Cultivation**

1 Introduction

This series research attempted to access the specific objectives as follows:
Developing an interactive learning platfom 'Gold Peach' for children based on the fundamental ideas of 'web community'.

Initiating the 'cultural' and 'cultivation' features on designing web environment.
Conducting a field study on focus groups to testify the usability of 'Gold Peach'. Two pretest groups have been done. A well-designed quasi experiment including 3 primary schools is still under going.

The series was conducted from 1996 to 2000. There were four generations of web-human interaction and user interface that had been developed and tested.

2 Literature Review and Problems Defining

2.1 Web Community

Web community was a progressive and extended concept from 'network-based learning community' that was introduced by Lave ea al. (1991)'s 'situated learning' and modified by Qiou (1996).

The components of network-based learning community were:
The organization of community: There were hardware, tools, and members. The community could be in an open or a closed form.

The learning activity: Lave et al. (1991) indicated it should have legitimate peripheral participation (LPP). Such participations included access, communication, learn to talk, collaborative learning and knowledge sharing.
The learning material: There were both existing material that was prepared in the learning database and

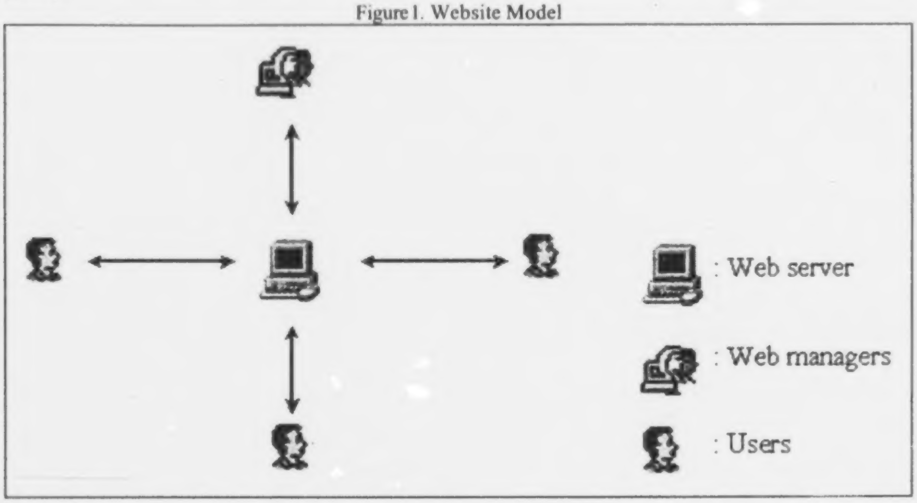
ongoing knowledge that was shaped by the collaborative learning processes.

The moderation: Lave et al. (1991) did not point out any leader in the community while Qiou (1996) advocated the necessary role of ' moderator' who would be the teacher to the other users (students). However, Kearsley (1997)' s idea could be noted here. He emphasized an online teacher is to coordinate the learning direction more than to dominant dogmatism.

After examining the literature above, the author suggested there should be the fifth element: ' the integrated interaction model' .

In general, the conceptual modes of websites interaction could be described as ' radiation model' (see Figure1):

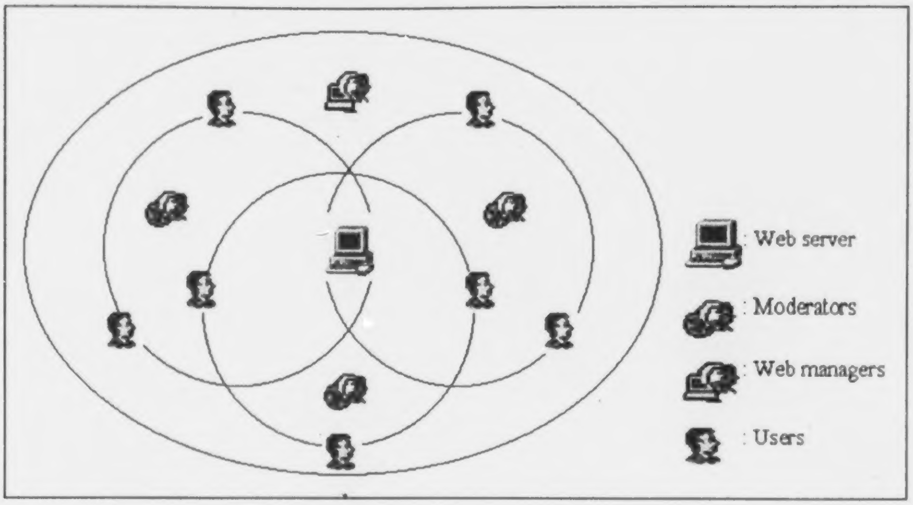
Figure1. Website Model



The website manager has a ' one to multiple' interaction with users through internet. The website manager will provide all web function, service content and all learning activities.

n practice, it is impossible to prepare complete and sophisticated learning material, achievement test, and all peripheral participation by a single manager or few individuals. It reflects the facts that a lot of existing learning websites that are lacking of updating or content depth.

Figure2. Web Community Model



Therefore, the author brought a new ' web community model' as Figure2.

This model designed two different interactions: systems functions and information contents. The website manager would only take the former responsibility. The information contents would be divided into more sub communities or interest groups that would be coordinated by external moderators. It was expected that there would be some interlaced area between groups, thus it would be linked as an integrated community. Group moderators did not have to worry about the web techniques; they could be concentrated to develop the learning behavioral interaction for users.

2.2 Culture

Internet makes the earth smaller, brings the world into a village. When we are celebrating the international boundary is falling down; do we regret that the pluralistic colors are also vanishing?

Though there are millions web sites, we have found the inevitable trend that the web characters grow similar faces, wear same uniforms, their interactions are more and more following consistent pattern. We cannot tell which web site is from a certain corner of which continent.

It worried him when the author called for a seminar of designing a new web with his college students. When we needed an innocent leading actress, there was only Snow White left in students' mind; when we made up a worrier model, the Black Knight came out; when we set up exploring plots, they were thinking of Star Trek. They ignored or forgot there are plenty of symbols and scientific fictional stories in Chinese history and mysteries. The young generation is losing its heritage of cultural imagination. (Wu, 1997)

The author suggested that we should remind web designers to consider ' cultural feature ' to be an essential factor for designing web. It would be not interesting, if there were no cultural differences in the cyber world. (Wu, 1998; Wu et al. 1999)

2.3 Cultivation

Media' s form (or environment) is as well as content may produce cultivation effect to children, according to Gerbner et al. (1979)' s series work concerning Media Sociology perspective. This idea may come from a long tradition of ' The Medium is the Message' (McLuhan, 1966). It argued that media itself would affect audience' s recognition, attitudes, and even behavior.

There were rich studies and documents on ' TV cultivation theories' in 1970s and 1980s. (Anderson, 1980; Hughes, 1980) Scholars advocated that there are heavy effects influencing children by television. They also found television would build up a 'media reality' which is far different from the 'real reality'. 'TV children syndrome' was discovered and considered a serious problem.

However, there was still a positive angle to this effect. We could conclude that although media might distort one's behavioral development, while it also might inspire one's mental potential especially in his/her childhood.

WWW is the most powerful media next to television. When we reviewed the lessons from television, the author wanted to suggest that developing web is not only defining a mechanism but also initiating an organism that might cause cultivation between community members.

The effect of cultivation could be operationalized and explored by users' behavioral changes after their experiencing the new media's form and environment. Therefore, the web community also needs a two-way feedback system to collect, measure, and interpret data that real users' innovation behavior, if there is any.

2.4 Current Learning Webs

The author thoroughly investigated ten significant current learning webs in Taiwan to understand if they also noticed the above three concepts. The observation could be summarized as:

Table 1.

	Web Community	Culture	Cultivation
Yes	2	0	1
No	8	10	9

Most of learning webs were in radiation model, one way teaching, and without any culture consideration. This fact explained the emerging need and encouraged the author to develop an integrated web learning community environment.

3 Methodology

As an application research, four methods were employed:
1. Literature reviews.
2. Depth interviewing with experts whose major is in children education.
3. Web systems analysis and design. Four requirements had been defined, they were:
-Total Web-Based CAI: including structural learning materials, systematic learning achievement tests, scores database, users demographic database, parameters base, and analysis tools.
-Interactive learning navigation: guiding users how to solve problems with internet resources instead of telling them the answers.
-Collaborative classroom: creating an online virtue space for the moderator and users to allocate assignments, talk over problems, display output, and share knowledge.
-Community management: verifying the applications for moderators, recognizing the rights of them, providing tools and interfaces for moderators to prepare learning materials, tests, and other collaborative activities.
4. Field study on focus group: two primary schools, one in Gi-Lung City and the other in Tau-Yuan County, had been selected as focus group, interaction and users' feed back had been analyzed for further rigid experiments.

4 Results

4.1 Community Environment and User Interface

The web was named 'Gold Peach Web Community'. Gold Peach is a magic fruit in West Holy Mother's garden based on Chinese ancient legend. You could navigate the cloud and explore unknown world after eating the Peach. The sprit of scientific fiction is as keen as modern imagination.

Since Gold Peach also appears in the famous Chinese classic fiction ' The story of the venture tour to West' , we adopted and inherited the background, characters and plots from the story to create the cyber environment of the web as Figure3.

After logging in the community, the child users could play roles as Magic Monkey, Pig, Sandman, Dragon Horse or other genius etc. They could follow Master Monk to break in 81 forbidden area that were controlled by different monsters and demons. They could steal Gold Peach to surf the WWW to find out the answers for their questions. Or, they might join one of parties in Flower Island where they could chat or work out a task together.

Figure3. Gold Peach Entrance

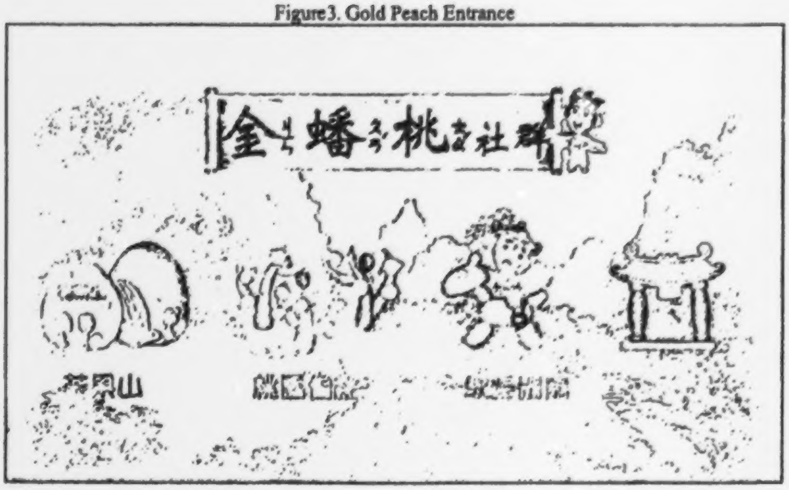
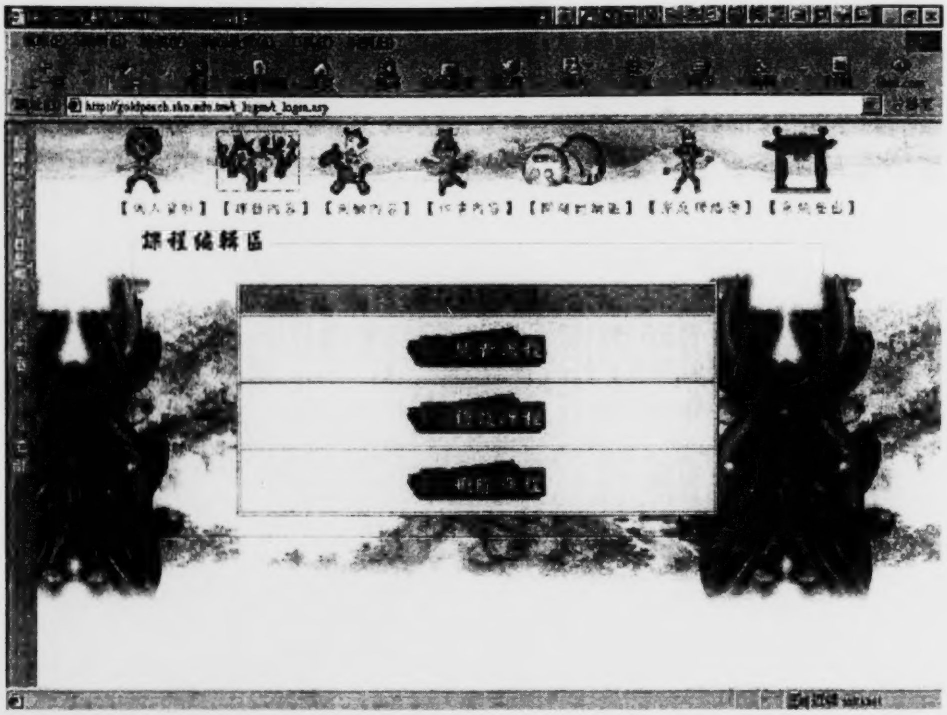


Figure4. Design Process



4.2 Interactive Learning Design Process

The moderator (teacher or expert) users could apply to be god or goddess in South Heaven Palace. After verification procedure, they would be authorized to be in charge a specific interest group to develop the learning interaction with child users.

With a easy, step-wise, and flexible tool (see Figure4), they could plan their syllabus and learning units. It was easy to reorganize and modify chapters and sections.

There were multiple functions to support moderators to arrange test. They could use either closed-ended or open-ended questions, single option or multiple choices. They also wanted to design some hints for the users who did not pass the test. They could set links to the internet resources where buried the treasure of answers.

They could also direct a virtue seminar or assign a fieldwork. All participants could exchange their idea or experiences upon moderators' requests.

All closed-ended questions in tests would be graded automatically while moderators would mark the open-ended questions.

The users scores and evaluations would be computed and organized in database. A parameter framework would be derived from a certain amount of accumulative data later on. In the same time, a report of user's learning achievement would be prepared for use's parents through web connection. Parents also could reply their comments to the moderators.

5 Conclusions and Discussions

5.1 Web Community: A progressive idea for learning environment

Web Community could be considered as a progressive idea for learning environment. It improved traditional one-way teaching and display and realized total peripheral participation and interaction.

The specification of ' Gold Peach Web Community' could be summarized as the following:
Developing interactive learning platform and environment where all community members could learn, solve problems, and share knowledge.

Consolidating learning contents that were combined primary schools' curricula with internet resources and information.

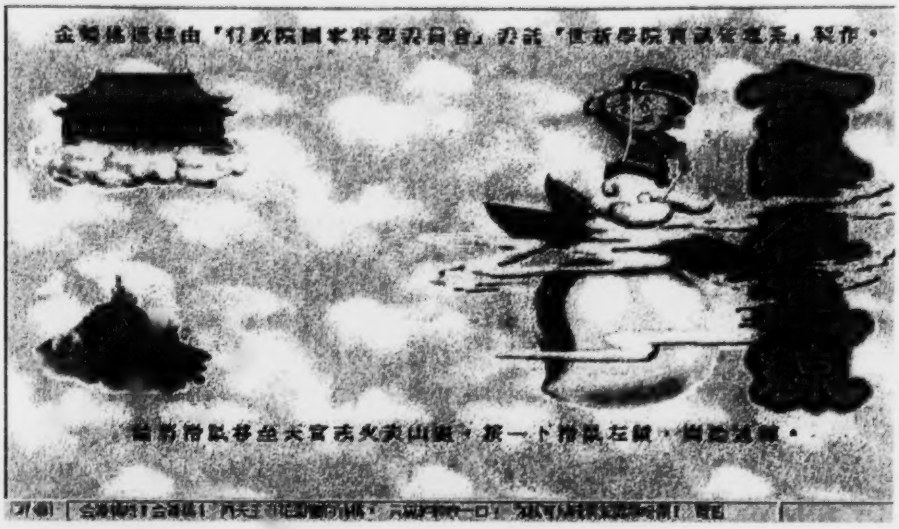
Reviewing and categorizing current information and webs that are suitable and interesting for children.

5.2 Culture: A deficiency, excess and integration trace

Three generations of the user interface were developed during last a few years. It revealed the introspection on seeking the cultural feature of web design.

Though the ' culture requirement' was highlighted according to the web developing strategy for the 1st generation, the implement was relatively unsuccessful. The artists in the project team were still lost in the long term Westernized training. The leading role, Magic Monkey, was cute, but lack of originality. The presentation of icons and background were inevitably under European shadow. (See Figure5)

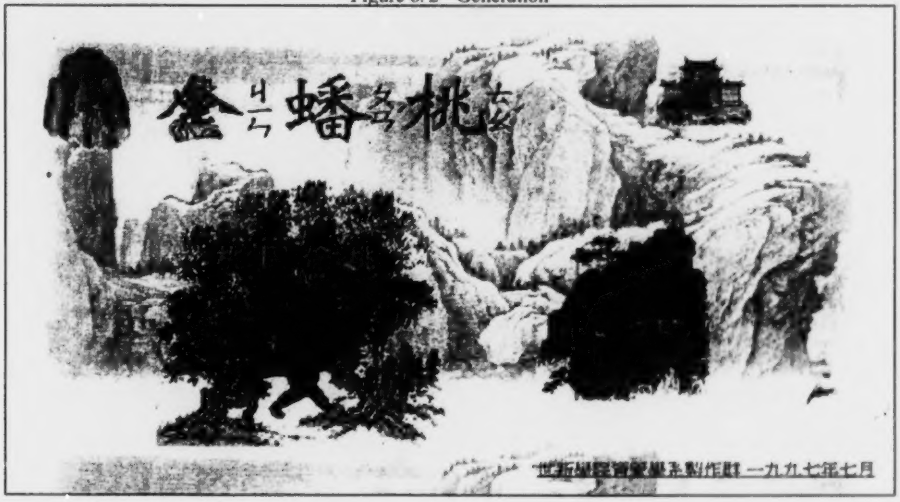
Figure5. 1st Generation



The effort on discovering lost tradition inspired the using of Chinese ink and calligraphy art to stylize the home page for the 2nd generation. The cultural specification was distinguished, however, the black-and-white idea was too abstract to attract children' s attention. (See Figure 6)

We did not find a balance between cultural skill and modern technique until the 3rd generation. We inherit the 3-D model of Chinese flour idol and the styling interest of folk drama to cerate cyber characters. The objects in the background were Chinese materials with modern simplified geometric outlines. The real culture should be a living idea that contented historic and current context. (See Figure3)

Figure 6. 2nd Generation



5.3 Cultivation: A ferment attempt

The result of this research ' Gold Peach Community' was expected to guide a new direction and a new method for children to develop their abilities of learning and problem solving under silent and positive cultivation.

The effort to discover the cultivation effect was still under ferment period. However, this research investigated and accomplished some feedback mechanisms in the systems. They could detect and reveal possible cultivation effects by comparing users learning behaviors and achievement. Since cultivation is more likely a time series effect than a sudden change, the author suggests a large scaled and longitudinal experiment on this issue in the future studies.

References

[1]Anderson, James A. (1980); The Theoretical Lineage of Critical Viewing Curricula; Journal of Communication; Vol.30, No.: 64-70

[2]Hiltz, S. R.; Teaching in a Virtual classroom; Proceedings of the 5th International Conference on CAI;Taipei: NSC; invited paper; 1995

[3]Kearsley, G.; A Guide to Online Education; http://gwis.circ.gwu.edu/~etl/online. html; 1997

[4]Lave, J. & E. Wenger; Situated Learning: Legitimate Peripheral Participation; London: Cambridge Univ. Press; 1991

[5]McLuhan, Marshall(1966); Understanding Media: The Extensions of Man; NY: McGraw-Hill; Ch.1

[6]Gerbner, George, Larry Gross, Michael Morgan and Nancy Signorielli(1979); Television Viewing and Fear of Victimization: Specification or Spuriousness; Annenberg, Penn.: The Annenberg School of Communications, Univ. of Penn.

[7]Hughes, Michael; (1980); The Fruits of Cultivation Analysis: A Reexamination of Some Effects of Television Watching; Public Opinion Quarterly; 46: 287-302

[8]Qiou, Guei-Fa; (1996); Situated Learning Concept and Computer Assisted Learning; Taipei: National Normal Univ. Press

[9]Wu, Tung-Xiung and Yui-Liang Chen; (1999) Cultural and Cultivation Features on Web Designing: A Case Study of Gold Peach Community; In Bullinger, Hans-Jorg and Jurgen Ziegler (eds.) Human-Computer Interaction: Communication, Cooperation, and Application Design; Mahwah, N.J.: Lawrence Erlbaum Associates; Vol. 2, p:66-70

[10]Wu, Tung-Xiung; (1998); Gold Peach Web Community: A Research and Production Project; Taipei: Project of NSC: NSC-87-2515-S-128-001-CH

[11]Wu, Tung-Xiung; (1997); A Research on 'Educational function' and 'Cultural Specifications' of Internet Services; Shih Hsin Journal; No. 6:115-27

Group Composition Methods for Cooperative Learning in Web-based Instructional systems

Yi-Hui Lee* and Nian-Shing Chen**
Department of Information Management
National Sun Yat-Sen University
** m8742618@mis.nsysu.edu.tw*
*** nschen@cc.nsysu.edu.tw*

The objective of this research is to find effective group composition methods to increase the interaction among students in asynchronous distance education using the theories of cooperative learning, group dynamics and social cognitive theory as foundations. The outcome can be a reference for the design of network cooperative learning activity and web-based instructional system in the future. This study is conducted in NSYSU Cyber University (http://cu.nsysu.edu.tw) using surveys and observations to investigate the influence of cognitive style on cooperative learning when different types of tasks are assigned. This research concludes that the choices of discussion tools in the chat room are different under intellective and decision-making tasks. Moreover, regardless of the task types, the heterogeneous groups outperform the homogeneous group during the cooperative learning process. Finally, the cognitive style is significantly related to group satisfaction in a cooperative learning environment

Keywords: **cooperative learning, web-based instructional system, cognitive style, group efficacy, group goal commitment**

1 Introduction

Group cooperative learning is defined as forming a group of two to six people with different abilities, genders or racial backgrounds. These differences may lead to effective interaction. If during the pursuit of personal goals, the group member can also consider other members and the group learning objectives, the learning efficacy can be improved [6]. Many of the previous researches use "gender" as group decomposition variable in investigating the effectiveness of cooperative learning under different task types. They find that the male groups usually outperform the female groups when computer is used in solving the tasks. However, "gender" should not be the only variable affecting the group performance. Thus, it is essential to conduct a research based on individual characteristics. Moreover, many scholars also point out that task types are one of the important variables in cooperative learning. When facing with different task types, the participants' discussion process evolved, skills required, communication tools used, and the communication methods adopted will all be varied.

From the social cognition point of view, group cognitive behavior, which is often ignored in-group performance experiment, is an important factor affecting group performance. In addition, group members' participation is another significant issue. The higher the participation rate, the more focused the members are in completing the tasks assigned. The group satisfaction will also increase [2]. Thus, this research chooses cognitive behaviors such as group participation rate, group efficacy and group goal commitment as important variables in cooperative learning. The objective is to find their impacts on group performance in different group types with different task types. Nunamaker et al. [5] point out that group; task, environment and technology are the four variables affecting the decision-making process in electronic meeting. In turns, they will affect the outcomes of the discussion. They are part of the input-process-output structure. This structure can be applied to this research on investigating the group cooperative learning in a web-based instructional system.

2 Literature Review

we consider those factors as follows:

- Cognitive style - Theory of field-independence

  When individual is having perception judgment, he/she is field-dependent if he/she tends to make decisions based on the surrounding. Otherwise, he/she is field-independent, i.e. the judgment is resulted from some inner reference.

- Task types

  The task types in this paper are the intellectual and decision-making task types under the "choose" category. According to McGrath [4] and Johnson [3], Intellective tasks are tasks with a "correct" solution. The solution may be obtained from calculating, choosing or creating. Decision-Making tasks are tasks with the most appropriate solution instead of the best solution.

- Group efficacy

  Bandura [1] thinks that group efficacy directly influences the extent to which group members can mobilize and coordinate their skills, the amount of effort they will put into the task ,and their persistence when group efforts fail to produce results. In addition, individual efficacy theory is widely applied to management, computer skill training and education. It is found that the individual with high efficacy level performs better.

- Group goal commitment

  Goal commitment plays an important role in goal setting. When group members identify with the goal of the mission, the main purpose is then to achieve the appointed or self-set goals and improve the group performance. Thus, there is a positive relationship between group goal commitment and group performance.

3 Research Methodology

The research structure is modified from the Electronic Meeting System (EMS) proposed by Nunamaker et al.[5]. Task types and cognitive types are the independent variables. This research focuses on finding their effects on cooperative learning process and performance in a web-based instructional system.

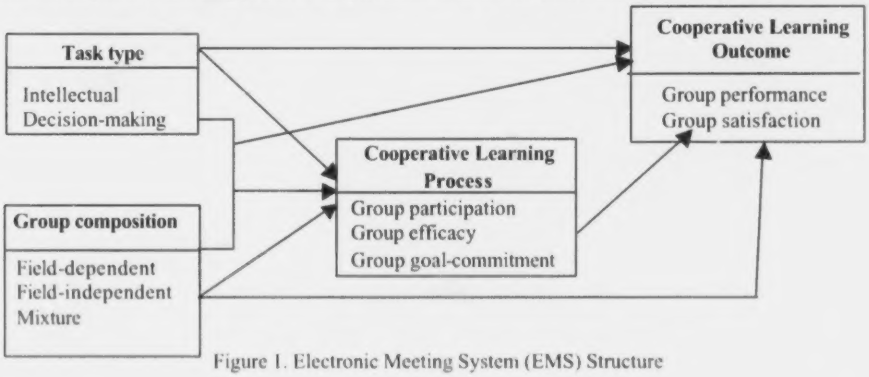


Figure 1. Electronic Meeting System (EMS) Structure

- **Samples**

  The samples are taken from master students of asynchronous Computer Networks and Internet course in NSYSU Cyber University. Most of the students are part-timed. The total number of students is 191. After rejecting students who did not complete the experiment, the valid sample size is 80 with an average age between 31 to 35. There are 59 males and 21 females. According to Group Embedded Figures Test, individual cognitive types are classified into two categories: field-dependent and field-independent. As a result, 35 people belong to field-independent category and the other 45 belong to field-dependent.

- **Group composition methods**

  Based on field-dependency, three types of groups are formed. They are groups with all field-independent individuals, all field-dependent ones and a mixture of the two. The average number in each group is about four or five. Since the field-independent samples are ten less than the field-dependent ones, there is a group with three field-independent and one field-dependent student.

For observation convenience, this group is classified as the 'all field-independent' class. Overall, there are six field-independent groups, seven field-dependent groups and seven mixtures, which add up to a total of 20 groups in this experiment.

- **Research procedure and its implement**

  At beginning of the semester, students are asked to complete a "Hidden Figural test" so that their cognitive types are known for later group composition. The experiment would start after groups are formed. There are three parts to the experiments where a task is assigned to each part. The sequence of the type of assigned tasks is intellective, decision-making and intellective tasks. All group members are new to each other. Thus, there is no previous interaction between them. The intellective task - I is therefore used as a warm-up exercise. Data from the other two tasks will be collected and analyzed. The samples are not informed of the difference between groups. The duration for each task would be one week. In addition, the cooperative learning process is sub-divided into two phases. After the tasks are given, the group members would have discussions on job assignment. This is called the "prepare phase". Each group member has to complete the group efficacy and group goal commitment surveys. After the groups complete the tasks and are aware of the group performance, the so-called "task complete phase" begins. Within this phase, each group member has to fill the surveys regarding the group satisfaction. Among the variables measured, group performance is graded after three experts have evaluated the task reports of each group.

- **Research Tools• •**

  Each group uses the discussion tools offered by NSYSU Cyber University for communication during the experiment. The tools available include group discussion board, chat room and mailing group. Group participation is measured based on the records of the use of the proceeding discussion tools. Regarding the group discussion board, the number of posting is recorded, whereas in the group chat room, the numbers of times individuals express themselves are recorded. In the mailing group, number of message sent is recorded.

- **Task Performance**

  Three experts review the outcomes of each group and they give each group an overall grade. Thus, the outcomes have a certain level of credibility.

4 Results and Analysis

This research uses t-test with independent variable - task type, to see if there is any difference between the average of group cooperative learning and its outcomes. The results show that the p-value for the group chat room category is less than 0.05. Thus, there is a significant difference. Since decision-making tasks encompass more areas than intellective tasks, more time and efforts are spent on them. Therefore, it is expected to find more frequent communication when this type of tasks is assigned. Many of the past researches find that groups communicate face-to-face outperform groups communicate via computers. This is not only because body languages can be used when members can see each other but also there can be instantaneous discussion on issues. Among the discussion tools, only group chat room is synchronous and allows instantaneous interaction. Group discussion board and group mailing list do not provide the same advantages.

When assigned with intellective tasks, there is a significant difference between the heterogeneous group (i.e. the mixtures) and the homogeneous groups in "group discussion board", "group chat room", group efficacy group satisfaction and group performance under the group cooperative learning category. This finding is consistent with the past researches because heterogeneous groups contain people with different characteristics and thinking pattern so that they can supplement and stimulate each other.

Our outcome shows there is a significant difference between heterogeneous group and the homogeneous groups in "group discussion board", "group chat room", and group efficacy when assigned with decision-making tasks. In the past, many researchers find that homogeneous group will perform better in communicative tasks but this is inconsistent with the finding of this paper. However, the paper is consistent with Johnson [3] who thinks that heterogeneous group outperform the homogeneous groups in creativity and decision-making tasks. In addition, it is found that there is a significant difference in goal commitment between field-dependence group and mixture during the cooperative learning process but not in Cooperative Learning outcome. According to the writer's experience in tutoring the class, it is concluded that the outcome may be affected by the performance of the previous intellective tasks. Part of the field-independent groups holds different opinions regarding the answers to the first and the third questions. This, in turn, affects the group members' answer to goal commitment survey in the decision-making tasks. This is related to the characteristics of field-independent members who often have more autonomy over outside messages. They process and decode messages according to their own cognitive reorganization style. They will not accept answers that are doubtful and uncertain to them.

The interaction of different task types and cognitive style have no significant impact on there is no significant difference on cooperative learning.

It is respectively concluded that to intellectual and decision-making tasks group cooperative process and its outcome have the following in common:

- 1• • There is a positive relationship between the number of posting during the group participation and group satisfaction level of group cooperation outcome.
- 2• • There is a positive relationship between the group efficacy during the group cooperation process and group satisfaction level of group cooperation outcome.
- 3• • There is a positive relationship between the group goal commitment during the group cooperation process and group satisfaction level of group cooperation outcome.

However, there is no significant positive relationship between group cooperation process variables and group performance when assigned with intellective tasks. This research concludes that since the intellective tasks have the one 'correct' solution, once the group members have deviation about the task, the group performance will be affected regardless of group efficacy or goal commitment.

5 Conclusion

From the survey, 86% of the participants agree that cooperative learning do increase the interaction among students. Moreover, 92% of the students are satisfied with the group discussion environment in the NSYSU Cyber University. This indicates that cooperative learning indeed reduces learning isolation and also heightens the students' learning motivation and willingness. Besides, it is concluded that heterogeneous groups outperform homogeneous groups in both group cooperative learning process and its outcomes within a web-based instructional system. However, field-dependent groups perform worse than the other two groups in both intellective and decision-making tasks. Since the field-dependent members are easily influenced by their surroundings and require the guidance of either teachers or well-performed students, they should not be grouped together when conducting cooperative learning in web-based learning environments. In addition, from the viewpoint of group dynamics and social cognition, group efficacy and goal commitment will affect the performance of the group cooperation. This research finds that there is a significant relationship between these variables. Under different task types, the group satisfaction is also significantly different. Thus, group efficacy and goal commitment can also be used as measurement in quantifying the outcome of group cooperation.

Acknowledgement

The Study is supported by the Program for Promoting Academic Excellence of Universities by Ministry of Education of R.O.C..

Reference

[1] Bandura, A.., "Social foundations of thought and action• A social cognitive theory", Englewood Cliffs, NJ• Prentice Hall, (1986).

[2] Cooper, M.R. & Wood, M.T., "Effects of Member Participation and Commitment in Group Decision Making on Influence, Satisfaction, and Decision Riskiness." Journal of Applied Psychology, 59(2),127-134, (1974).

[3] Johnson, D. W., & Johnson, F. P., "Joining together: Group theory and group skills", Boston: Allyn & Bacon, (1997).

[4] McGrath, J.E., "Group: Interaction and Performance", Prentice Hall, Englewood Cliff, NJ, (1984).

[5] Nunamaker, J.F. Dennis, A.R. Vslscich, J.S. Vogel, D.R. & George, J.F., "Electronic Meeting Systems to Support Group Work.", Communications of the ACM, 34:7,pp. 40-61, (1991).

[6] Spink, K. S., "Group cohesion and collective efficacy of volleyball teams", Journal of Sport and Exercise Psychology, 12, pp. 301-311, (1990).

KnowDisLC: A Knowledge Distributed Web-Based Learning Community for University Students

Chi-Cheng Chang
Graduate Institute of Technological and Vocational Education
National Taipei University of Technology
No 1, Sec. 3, Chung-Hsiao E. Rd., Taipei, Taiwan 106
Fax: +886-2-27812897
E-mail: samchang@mail.tku.edu.tw

The study has constructed and evaluated a knowledge distributed web-based learning community (KnowDisLC), in hopes that it will help students form a virtual learning community through web-based learning, which they can use to facilitate learning and growth. Ultimately they would like to accomplish the goals of knowledge sharing, resource sharing, information interchange, and emotion exchange. Both a point accumulation mechanism and a web-based learning record have been the features of the KnowDisLC system which prove to stimulate student involvement by allowing them to know about the performance and involvement of themselves and their peers. Most students agree that the community could help them learn more and faster, and most students also confirm that the overall operation and implementation of the system is generally good.

Keywords: **Learning Community, Distributed Knowledge, Web-Based Learning, Virtual Community**

1 Research Background

There are a few true web-based learning community systems whose foundation is built on a knowledge community and a learning buddy, with focus on knowledge sharing and creation, and corporate growth of community membership. However, a good deal of successful cases of web-based learning community can be are found in the USA. For example, CoVis (Learning trough Collaborative Visualization) link experts, teachers, students and field workers together to form a learning community of the visualized collaborative science learning (Pea, 1993); CSILE (Computer Supported Intentional Learning Environment) is based on a collaborative database and tries to promote student thinking and meta-cognition without emphasis on any specific field of knowledge (Scadamalia, Beriter & Lamon, 1994); The LabNet, a learning community aims at cultivating middle school teachers' academic specialties (Spitzer & Wedding, 1995); TENet (Texas Educational Network), a learning community targeting middle and elementary school teachers, as well as government officials, college professors, graduate students, and field experts involved with middle and elementary school education; Wired for Learning which helps teachers, students, parents and other members to establish a collaborative learning community (Kuang, Grueneberg & Lam, 1998); OWLink system which encourages teachers to use technology to cultivate learning ability and to form a distributed learning community (Miller, 1998); Thought system of learning the Mission to Mars, a collaborative learning experience between peers and experts (Brown & Campione, 1994).

A learning community has three features: (1) spontaneous learning and the active knowledge construction of individual learners; (2) idea sharing and information providing for all members of the learning community; and (3) distributed knowledge and expertise. Accordingly, no one will possess a special knowledge. It is distributed among different people, objects or tools. It is through interaction, discussion, communication, instruction, sharing or utilization of tools that such knowledge will be shared. When a student is faced with a specific problem, the distributed expertise that the members of the learning community possess can give him support and aid, and the goal will be accomplished through their shared collaborative activities. The intelligence of the community members will be improved through their sharing of expertise.

Distributed intelligence, distributed knowledge and distributed expertise are similar ideas, and they are the fundamental concepts of the learning community. According to Goodyear (1995), the term of 'distributed knowledge' with two sets of connotations. One emphasizes that knowledge is distributed in a community of practice, which means an expert in one field may a novice in another. Another emphasizes that working knowledge is situated in various manners, eg. embedded in the practice of workers; made articulate in reading, discussion, and conferences.

The CTGV team of Lin et al. (Lin & CTGV, 1996) also mentions the effective use of distributed expertise to achieve multiplicity, creativity and flexibility of learning. In this research the author has constructed a web-based knowledge distributed learning community based on the distribution, sharing and provision of knowledge. The system has been experimented on subjects of the university to evaluate its functions and effectiveness. The purpose of the research is:

1. to explore the learning concepts of a knowledge distributed web-based learning community (KnowDisLC);
2. to construct a knowledge distributed web-based learning community (KnowDisLC) and to evaluate its functions and effectiveness; and
3. to propose an environmental framework for a knowledge distributed web-based learning community (KnowDisLC).

2 Framework and Features of KnowDisLC Environment

2.1 Framework of the System Environment

The framework of the KnowDisLC system environment is shown in terms of user, system functions and database files. (see Figure 1)

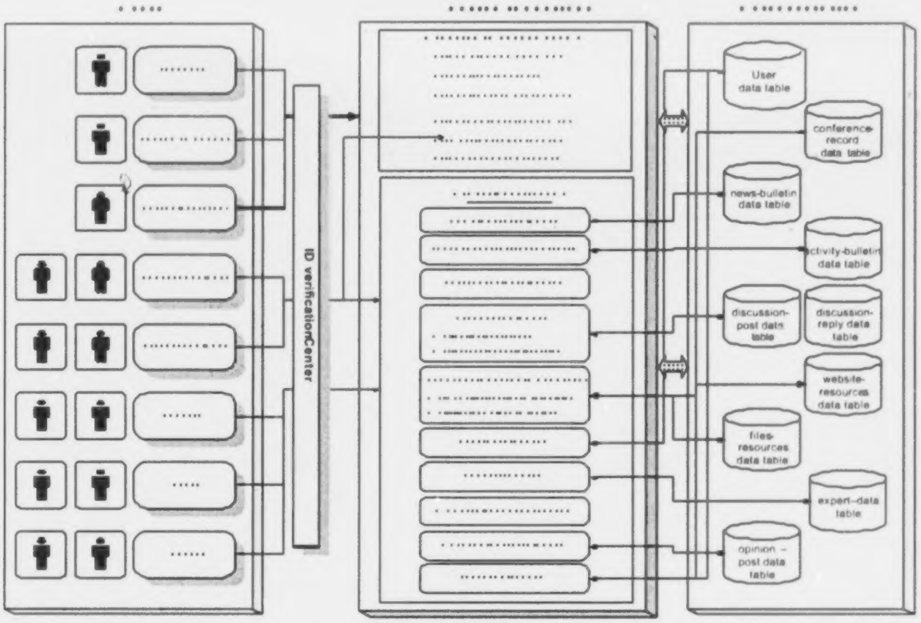

ID verificationCenter
User data table
conference-record data table
news-bulletin data table
activity-bulletin data table
discussion-post data table
discussion-reply data table
website-resources data table
files-resources data table
expert-data table
opinion - post data table

Figure 1. *Framework of the KnowDisLC system environment*

2.2 System Features

The construction of a point accumulation system of learning activity is one of the features of the KnowDisLC system (http://www.etwblc.et.tku.edu.tw) to display both the learning score and number of visits of each user. It is a reference for performance evaluation of students. To increase student motivation, the system will give users different scores according to their involvement in the web-based learning, e.g., logging on to the system (1 point a day), provision of a learning resource, provision of a file resource, provision of related sites, participation in discussion (raise questions and make replies), hosting a discussion or conference. The second feature of the KnowDisLC system is the provision of a web learning status log, including learning log statistics, conference minutes, assignment upload statistics, performance statistics of discussion or conference host, etc. so that students can know their learning status at anytime and use it as a reference for correction. The web site and file resource sharing and provision functions are based on the concepts of sharing and provision of knowledge, distributed knowledge, knowledge building, and information exchanging. This is the third feature of the KnowDisLC system. Community members can register or link to the URL address of a related learning resource site and upload or download files and materials related to course subject for the goals of collaboratively academic growth.

3 Data Bases of KnowDisLC

There are six database files in the KnowDisLC system, including ten different data tables. Here is a description of the functions and utilizations of the data tables.

User data table. User ID is the primary index key of the data table. There is no associate column. It is a record of a user' s basic data and learning activity such as ID, name, log-in password, learning resources sharing record, discussion post/reply involvement record, log-in record, and accumulated point value.

Expert data table. Expert ID is the primary index key of the data table. A one-to-one association is adopted to associate the user ID in the user data table and the user ID of the expert data table. It is a record of the experts basic data, including educational background, present employment, and the expert' s specialty.

Website-resources data table. Website URL address is the primary index key of the table, and there is no associate column. It is a record of the basic data of the websites shared by the community members such as site organizations, site fields, applicable users, approval status, and suppliers.

File-resources data table. Filename is the primary index key of thedata table, and there is no associate column. It is a record of the basic data of files shared by the community members such as file name, size, format, description, approval status, and suppliers.

Discussion-post data table. Discussion Issue ID is the primary index key of the data table, and there is no associate column. The data table chiefly provides a discussion board for users to post their articles. It is a record of discussion issue ID, discussion issue, and basic writer data, such as writer name, article contents, date of posting, and the total number of articles of the same issue.

Discussion-reply data table. Discussion Issue ID is the primary index key of the data table, and a one-to-multiple association is adopted to associate the discussion issue ID in the discussion- post data table with the discussion issue ID of the discussion-reply data table. The data table chiefly provides a discussion board for users to reply their ideas to discussion. It includes such items as discussion issue ID, reply ID, replier basic data, such as replier name, reply contents, and date of reply.

Opinion-post data table. Opinion ID is the primary index key of the data table, and there is no associate column. It is a record of user opinions, such as user basic data, opinion contents, and date of posting.

Activity-bulletin data table. Activity bulletin ID is the primary index key of the data table, and there is no associate column. It is a record of community learning activity bulletins, such as announcer basic data, bulletin contents, and date of bulletin.

News-bulletin data table. New bulletin ID is the primary index key of the data table, and there is no associate column. It is a record of community news, such as announcer basic data, bulletin types (system bulletin, school bulletin, curricular bulletin, information report), bulletin contents, and date of bulletin.
Conference-record data table. Conferencing minute ID is the primary index key of the table, and there is no associate column. It is a record of the online conferences of the community, including date of initiation,

date of completion, and contents of conference.

4 System Functions of KnowDisLC

The KnowDisLC System functions are as follows:

Account authority level. Account authority level is a means to classify the authority for access to the system by different users. There are 5 levels at the moment: system manager, conference host, discussion host, general user, and guest.

ID verification center. This is to verify the ID and password of users at login and registration. After registering, the system will send a letter of ID verification to the user' s e-mail box; the letter will include a randomly assigned password for the user to log-in the system for the first time. The e-mail verification is to further confirm the e-mail account of the user to facilitate the delivery of mail from the system in the future.

News bulletin board. It provides dynamic up-to-date information, including a 'system bulletin', 'school bulletin', 'class bulletin', and 'information bulletin'. Bulletins that have been posted for over one week will be automatically moved to the ' old bulletin box' ; users can browse old news or information there. Dynamic HTML flexible menu has been adopted in the system to avoid a problem of long screen resulting from too many sub-menus.

Online user display. A dynamic user number is displayed on the left bottom corner of the screen to enable users to know the number of visitors online, so that they won' t feel lonely during their learning on web, and they can call another member of the community online.

Discussion board. This provides 'synchronous online conferencing', 'host conferencing', 'asynchronous discussion', 'online calling' and 'host list' functions. Users may partake in distance conferencing, or they may publish and discuss articles through asynchronous discussion board. In addition, the discussion board provides a conference/discussion host, system manager, online assistant and teacher with management functions. For instance, a host may use the conference-record function button for the host conference to take down all the contents of the discussion as a reference for teachers and students. A host can also announce or remove the time and topic of a web conference. The host may also modify or remove from the academic discussion all articles of an improper issue or content which have been put online.

Curricular data center. It provides online curricular outlines and multimedia presentation materials for users to online browse or download for offline reading, which can be used for preparation before class and revision after school.

Learning activity bulletin. A teacher may reveal the newest learning activities here, such as personal assignment, project-based assignment, problem-based assignment, collaborative learning, group list, examination information. The bulletin includes ' bulletin announcement' and ' bulletin browse' . The 'bulletin announcement' function is only assigned to the system manager, teacher, and online assistant); while the ' bulletin browse' function is assigned to students.

Learning resources share and provision. This is designed in stays true to the spirit of ' knowledge share and provision and distributed knowledge' to provide 'website-resources share', 'website-resources provision', 'files-resources download' and 'files-resources upload' functions. Users may enter information and URL address of related websites or link to related websites and upload or download related materials for knowledge sharing, resource sharing and information interchange.

'Website-resources share' enables users to link to related websites; websites are listed by site nature, field, user suitability, and site organizers. The function also displays the new websites provided by users within the last 1-4 weeks and 1 month. 'Website-resources provision' function enables users to enter information and URL address of websites related to respective curricula.

In the 'files-resources download', files are classified as ' descriptive documents (.doc)' , ' presentations (.ppt)' , ' related tools (.exe)' , and ' others' . Users may download or browse these. The ' files-resources upload' function enables users to upload data files by means of a web-based FTP, so that users can exchange their data on the web for resources sharing and interchange.

User data center. The center provides ' personal data inquiry' , ' personal data edit' , ' user inquiry' and ' user data list' functions to enable a user to query and modify his own data, view the data of other users, browse the learning status of his own or other users and accumulated point record. The 'user data list' contains information such as user ID, Chinese name, nickname, log-in frequency, last-log-in date, last-log-in time, total accumulated points. This enables users to know the log-in status of other users.

Expert inquiry. There are three functional modules in this area, including 'expert list', 'expert registration', and 'management' module. The term ' Expert' refers to both ' experts' and ' little teachers' (students); users may ask them questions through e-mail. A user may become an expert or little teacher by using the expert registration function provided by the system once his log-in accumulated points have reached a certain standard and he is interested in becoming one to help other students. Users who are given system management authority (teachers, system manager, and online assistant) can remove data provided by unqualified experts.

Website resource search. The most often used and prominent search engines are provided to enable users to run a remote search by inputting key words. In addition, the function enables users to link to websites not directly related to curricula (such as libraries, related organizations and institutions, net bookstores, and other websites), so that a user may use other resources from within the system.

Opinion bulletin board. This enables users to state their own opinions and to browse the opinions of others in order to establish a humanistic virtual community. A user may choose from within a set of 16 emotional patterns provided by the system to express his feelings. The system will automatically display a week' s worth of contents on the bulletin board when a user logs in.

Point accumulation system. To encourage user involvement in learning activities, we have designed the 'point accumulation system'. When a user participates in any of the community activities, he will be given a set number of points. Furthermore, the point accumulation system will provide a reference for teachers to evaluate student involvement and to open advanced functions. (see Figure 2)

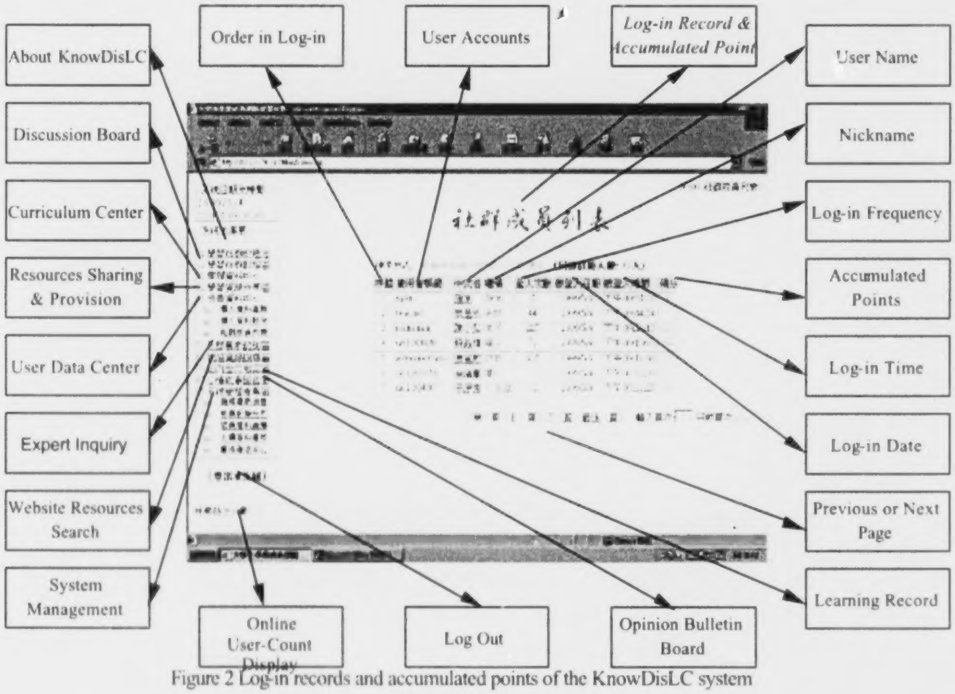

About KnowDisLC
Order in Log-in
User Accounts
Log-in Record & Accumulated Point
User Name
Discussion Board
Nickname
Curriculum Center
社群成員列表
Log-in Frequency
Resources Sharing & Provision
Accumulated Points
User Data Center
Log-in Time
Expert Inquiry
Log-in Date
Website Resources Search
Previous or Next Page
System Management
Learning Record
Online User-Count Display
Log Out
Opinion Bulletin Board

Figure 2 Log-in records and accumulated points of the KnowDisLC system

Web-based learning record. This provides information about a user's learning status on web, including 'learning record statistics', 'browse conferencing record', 'assignment upload statistics', and 'host performance' to enable students to understand their own progress, learning status, and performance by viewing other users' learning activity records and summaries. This will stimulate the visit of log-in and revision of learning. The current problem, however, is that the system is unable to detect what students are doing when they are actually on the site, including what and when they are browsing. This is what we are trying to improve the KnowDisLC at the moment.

System management. This provides online system management to teachers, online assistants and system managers, and includes 'news announcements', 'user log analysis', 'user data maintenance', 'upload data reviews', 'mail delivery center' (see Figure 7), and 'web conferencing record' functions. The system can automatically identify a user's account authority level according to his user ID, and no additional password is needed.

5 Implementation and Evaluation of KnowDisLC

5.1 Implementation

During the 3-month (mid March to mid June of 1999) implementation of the learning community, there were 96 users; this includes 32 undergraduate students taking the 'Distance Education' course, 35 undergraduate students (including in-service teachers getting on-the-job training) taking 'Computer and Instruction' course ('Distance Education' is included in the curricula), 1 professors, 1 system manager, 1 online assistant from the Department of Educational Technology of Tamkang University, 2 experts from outside of the university, 1 guest account (but 86 access frequency), and 23 users from other schools recommended by community members.

The system runs in cooperation with the classroom instruction. Students are required to visit the website and participate in the learning activities, including browsing the online materials (for preparation and revision), learning activity bulletin and news bulletin, hosting conferences and discussions every term, and participating in online synchronous conferencing and asynchronous discussions. Moreover, students are required to participate in problem-based learning, project-based learning, problem exploration and knowledge interchange in collaborative groups, for the production of mid-term examination questions, assignments, electronic presentations (e.g. Powerpoint files), and term projects, etc.

5.2 Evaluation of Functions and Effects

Its purpose is to understand the effects and pertinence of the implementation of the KnowDisLC in university education. The evaluation of the system covers user-based evaluation, expert-based evaluation, and in-depth interviews.

5.2.1 User-Based Evaluation

The evaluation is conducted through a questionnaire survey; a self-developed Likert's 5-point rating scale evaluation form has been distributed to the students. The questionnaire includes six main evaluation items, system contents, screen design, user interface, system functions, learning effects, and system uses.

Users comment on the four evaluation items, the system contents, screen design, user interface, and system functions with an average of over 4.0. With regards to the results of learning effects (see Table 1), most students consider that the KnowDisLC can help one learn more and facilitate his/her professional growth. They are more than happy to join learning activities and other learning communities of such a nature in other classes; some students, however, have had contrary opinions which reveal that the learning effects of a web-based learning should be improved more and discussed in further research.

With regards to system use, most students approve of the overall operation and instructional application of the KnowDisLC system. The items that have received negative feedback are the less-frequently used functions such as 'expert inquiry', 'online calling', and 'online synchronous conference.' The results show that although the system functions and learning effect are generally both good, there is still room for improvement with uses, operation, implementation and management of the system functions.

Table 1 Percentages and averages of student agreement in KowDisLC impacts on learning

[illegible]	[illegible]					
	[illegible]					
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] *Opinion bulletin board* make me know the feelings of other students and achieve the goal of emotion exchange	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Note. The numbers of 5, 4, 3, 2, 1 denote a 5-point rating scale with 5 being strongly agree and 1 being strongly disagree.

5.2.2 Expert-Based Evaluation

The evaluation was conducted by three experts with backgrounds in both education and information technology . The evaluation is aimed at the system contents, interface design, system functions, and system application. The evaluation includes two parts. One was a presentation by us on the objectives of our research and system functions of the KnowDisLC system; this presentation was complete with onsite operation afterward. Then there was an in-deep interview with the experts. For the second part, we sent the URL address of the KnowDisLC to the experts to let them use the system alone. Then they gave their opinions return by mailed back their evaluation forms in a few days.

In conclusion, the experts believe that the system functions are quite serviceable, the system architecture is pretty complete, and the menu arrangement is appropriate. It should satisfy the needs of both students and teachers. Nevertheless, the automatic management and learning management sections can both be further improved.

5.2.3 In-Depth Interviews

According to several factors such as the log-in frequency and accumulated points from the user data center and the web-based learning record and academic performance, 6 subjects were chosen by group sampling from three different learning performance groups (3 from each) (high score group A, middle score group B and low score group C). Then an in-depth interview was conducted according to the results of the user evaluation questionnaire to understand the details of the system effects and to collect data concerning the problems, difficulties and impacts on the learning of the system from the case studies. In addition, interviews with the teacher were scheduled to better understand the learning status of the students from the viewpoint of instructor.

The results show that students who have a better performance in web-based learning (e.g. group A—more motivated in web-based learning and active in related activities) are also those who have better class performance. Similarly, students with a worse performance in web-based learning (e.g. group C—low involvement in web-based learning and related activities) are those who have a worse attitude towards learning in class. From the interviews with the 6 subjects, we discovered that students from groups A and B could make more constructive and solid suggestions, while students from group C were unable to make any clear comments on the learning community (e.g. What kind of improvements does the KnowDisLC system need? What is your strategy for using the learning community to learn?).

In general, we discovered that factors affecting willingness to get involved in the web-based learning community included self-expectation of learning, individual learning attitude and motivation, experience in computer and Internet use, individual preferences, and other personal factors.

6 Conclusions and Suggestions

The research has constructed and evaluated a distributed knowledge learning community as an aide to web-based learning, in hopes that it will help students form a virtual learning community through web-based learning, which they can use to facilitate learning and growth through the curricular data center, discussions, conferencing, learning resources sharing and to provide, expert inquiry, web resource searching, and an opinion bulletin board. Ultimately they would like to accomplish the goals of knowledge sharing, resource sharing, information interchange, and emotion exchange. Both a point accumulation mechanism and a web-based learning record have been the features of the KnowDisLC system which prove to stimulate student involvement by allowing them to know about the performance and involvement of themselves and their peers. The system has been officially implemented in a university course for 3 months, and both the implementation and operation are running smoothly. The system evaluation shows that most users are satisfied with the system contents, screen design, user interface, and system functions. Most students agree that the community could help them learn more and accelerate their professional growth, and most students also confirm that the overall operation and implementation of the system is generally good.

In the future, we will reinforce: system function expansion and maintenance; the automatic management, and the learning management in particular (such as a mechanism of learning resources establishment and management); web page browsing record and learning path management; web-based learning duration and log-out time; learning resources and website browsing time; automatic approval functions of website upload; graphic display and full text indexing of discussions board and activity bulletin; cross-disciplinary uses of the system; an online assessment (e.g. web-based portfolio), in order to optimize the system. Subsequent research will also include qualitative and quantitative experimental studies of the system application, in order to understand more about the students' learning behavior pattern and its substantial effects on the students.

References

[1] Brown, A.L. & Campione, J.C., "Guided discovery in a community of learners", K. McGilly (Ed.), Classroom lessons: Integrating cognitive theory and classroom practice, Cambridge, MA: MIT Press, pp.229-270, (1994).
[2] Goodyear, P.,."Situated action and distributed knowledge: A JITOL perspective on EPSS", Innovations in Education and Training International, Vol.32, No.1, pp.45-55, (1995).
[3] Kuang, L., Grueneberg, K., & Lam, R., "Education on the net: Constructing collaborative learning communities", Proceedings of the 6th International Conference on Computers in Education (ICCE'98), Beijing, China, pp.543-545, (1998).
[4] Lin, X. & CTGV., "Instructional design and the development of learning communities", B.G. Wilson

(Ed.), Constructivist learning environments: Case studies instructional design, NJ: Educational Technology Publications, pp.203-220, (1996).

[5] Miller, L. M., "Teacher's users of an electronic environment: A case study of project OWLink", Proceedings of The 6th International Conference on Computers in Education, Beijing, China, pp.459-465, (1998).

[6] Pea, R., "The collaborative visualization project", Communications of the ACM, Vol.36, No.5, pp.60-63, (1993).

[7] Spitzer, W. & Wedding, K., "LabNet: An international electronic community for professional development". Computers and Education, Vol. 24, No.3, 247-250, (1995).

[8] TENet (Texas Education Network), URL: http: //www.tenet.edu, (1997).

A Web-based EFL Writing Environment: Integrating Information for Learners, Teachers, and Researchers

David Wible*, Chin-Hwa Kuo, Anne Liu* and Nai-lung Tsao****
* *Graduate Institute of Western Languages and Literature*
Tamkang University
Tamsui, Taipei Hsien, Taiwan
dwible@mail.tku.edut.w
lieor@ms7.url.com.tw
***Computer and Networks (CAN) Laboratory*
Department of Computer Science and Information Engineering
Tamkang University
Tamsui, Taipei Hsien, Taiwan
chkuo@mail.tku.edu.tw
g6190173@tkgis.tku.edu.tw
Taiwam

With the rise in the popularity of web-based education, there is a pressing need for the design of web-based systems that are domain-specific. This need is particularly acute for the domain of second language education, where generic web-based systems fall short of fulfilling the potential of the Internet for meeting the particular challenges faced by language learners and teachers. A novel interactive online environment is described which integrates the potential of computers, Internet, and linguistic analysis to address the highly specific needs of second language composition classes. The system accommodates learners, teachers, and researchers. A crucial consequence of the interactive nature of this system is that users actually create information through their use, and this information enables the system to improve with use. Specifically, the essays written by users and the comments given by teachers are archived in a searchable online database. Learners can do pinpoint searches of this data to understand their individual persistent difficulties. Teachers can do the same in order to discover these difficulties for individual learners and for a class as a whole. The modular system provides interfaces with functions to facilitate an array of user tasks such as teachers' correction of essays and learners' writing and revision processes. Researchers' error analysis of learner essays feeds an active online help function as well.

Keywords: **applications in subject areas; architectures for educational technology system; interactive learning environments**

1 Introduction

The purpose of this paper is to describe one module in a highly integrated language learning environment called IWiLL (Intelligent Web-based Interactive Language Learning: http://www.can.tku.edu.tw/iwill). The module within IWiLL which we focus on in this paper is a novel web-based writing environment designed for EFL composition classes.

The design of the IWiLL writing environment is based upon certain general assumptions. First, the ideal online system for EFL writing classes should be interactive. Second, the system should exploit the computers' capacity to track the content of the interactions between users and to enable users to do pinpoint searches of the record of these interactions. This feature makes available invaluable information that can serve as a cumulative source of insight for both learners and teachers, information which in traditional writing classrooms remains scattered, ephemeral, and highly inaccessible. Third, while the system described here is designed for second language writing classes, it is more accurately seen as one component in an integrated language learning environment that includes other skills, such as reading and listening (Kuo, Wible, and Chio, 2000; Kuo, et. al., 2000). The modularized and integrated design is intended to accommodate recent trends in language pedagogy which view language skills as best learned in an integrated whole rather than as a set of separate, independent skills. Finally, while the IWiLL environment is designed specifically to meet the needs of certain type of language course (second language composition) it is intended to provide as much freedom as possible for teachers within this domain to use their own approaches and materials of their choice.

2 The Organization of the System

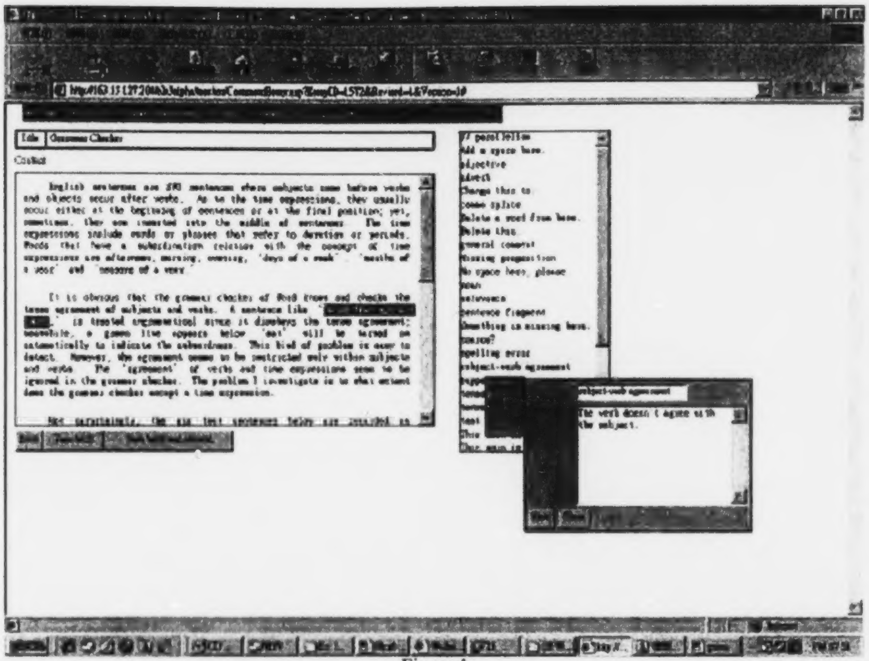
2.1 The Teacher's View

A registered teacher who logs onto the system is presented a display screen of various links to components within the system. To correct student essays, the teacher links to a page which displays their student roster.

From this roster screen, the teacher retrieves the essay by clicking on the button that represents that essay on the roster page. To mark the essay with a comment (for example, to mark a run-on sentence or subject-verb agreement problem), the teacher first chooses the portion of the essay targeted for comment using the mouse. Once the relevant text has been selected, there are two ways for the teacher to provide the student with a comment on it. The first is to simply type the comment in the empty text box provided especially for the teacher's comment and then, once the comment has been composed, append it to the intended portion of the student's text by clicking on the appropriate button ('Give the comment'). The second way of providing a comment is to choose one that has been stored in a "Comment Bank." This second way deserves some elaboration.

The Comment Bank provides each teacher with a convenient means for storing and reusing frequently used comments. To retrieve a stored comment and append it to the portion of the student essay, the teacher simply selects that comment from a drop-down menu and clicks on it. The teacher can add new comments to her Comment Bank at any time. (See Figure 1)

At this stage, research is needed to understand the factors effecting how beneficial various sorts of comments are in helping students with their writing. An advantage of this system is that, with it, researchers can control the crucial variables (such as the precise form and content of the teacher feedback being investigated), and it makes readily available the data needed for such research since the marked and unmarked essays are archived in forms that can be queried. Moreover, the revised versions of an essay can be examined along side the teacher's comments that were given to the student on the original version of the essay, making it possible to easily track the influence of various types of teacher feedback.



The verb doesn't agree with the subject.

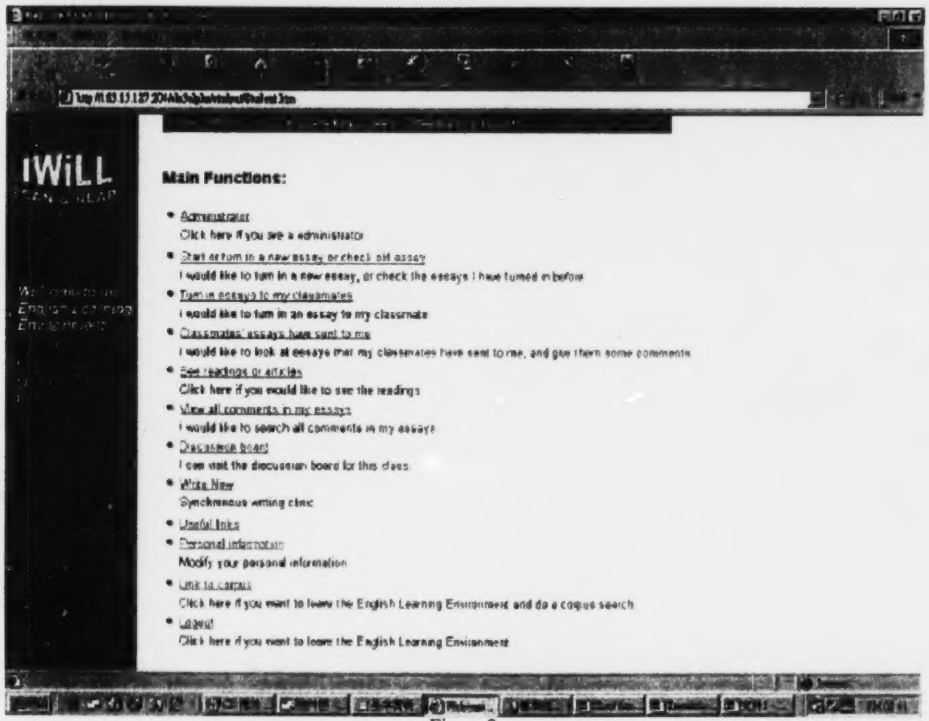
Figure 1

It is important to notice the distinction between this essay-marking function and the superficially similar functions offered in commercial word processors such as Microsoft Word. Like our system, those programs allow users to select portions of text and annotate them with comments. While the convenience that this provides to users as a communication tool is essentially the heart of the function's role in these commercial word processing systems, in our system this convenience is a relatively incidental (though valuable) advantage. For us, the substantial value comes from a set of related features which the word processing programs do not offer. Specifically, all of the annotations provided in our system by teachers when they mark essays are permanently indexed, by way of database technology, to the portions of text that the teacher has marked. Moreover, the essays themselves along with the indexed teacher comments enter a permanent corpus of learner essays that can be searched on line. Information extraction techniques, then, make it possible to provide learners and teachers with instant cumulative profiles of the trouble spots of individual learners, of whole classes of learners, or subtypes of learners selected by a wide variety of criteria. For example, the system enables teachers to retrieve all tokens that have been marked with a particular error type either from the essays of a single learner or from the essays of groups of learners. Moreover, teachers can retrieve the tokens of every error type and display them in order of frequency, with the error type that has been marked on the highest number of text portions listed first.

The role which our commenting function can play is deepened greatly by the highly integrated nature of our system design. Not only does it support profiles of entire groups of learners, but the analysis of the common errors can be immediately used by researchers to analyze the sources of learner difficulties. This sort of data makes it possible to investigate pervasive patterns of difficulty in the learners' English (that is, to investigate what some applied linguists call the 'interlanguage' of learners). Results of such analyses can directly enhance the entire web-based writing platform. Specifically, we have developed an authoring tool for designing online help which targets precisely the problems uncovered in the analysis of learners' errors. Moreover, based upon this sort of data, researchers can improve the design of teaching and reference materials. (See section 2.3 below for more details.)

2.2 The Student's View

A registered student logging onto the system is first shown a menu of links, including a link to a discussion board dedicated to the students in that class and links to helpful websites for ESL writers. To compose or turn in an essay, the student links to a page that displays a row of colored buttons, basically each button (or cluster of buttons) representing a different essay the student has written or is in the process of writing. From this page, the student can opt to resume work on an unfinished essay or revision, or to submit or compose a new essay. (See Figure 2)



Main Functions:

- Administrator
  Click here if you are a administrator
- Start or turn in a new essay or check old essay
  I would like to turn in a new essay, or check the essays I have turned in before
- Turn in essays to my classmates
  I would like to turn in an essay to my classmate
- Classmates' essays have sent to me
  I would like to look at essays that my classmates have sent to me, and give them some comments
- See readings or articles
  Click here if you would like to see the readings
- View all comments in my essays
  I would like to search all comments in my essays
- Discussion board
  I can visit the discussion board for this class
- Write Now
  Synchronous writing clinic
- Useful links
- Personal information
  Modify your personal information
- Link to corpus
  Click here if you want to leave the English Learning Environment and do a corpus search
- Logout
  Click here if you want to leave the English Learning Environment

Figure 2

To compose an essay, students can elect either to compose online by typing their essay within a designated text box on the appropriate page or to copy and paste into that box an essay composed off-line. The latter essays are imported as text files.

From this screen where the essay has been composed or imported, students can submit the essay to the instructor. Alternatively, through a drop-down list of all of their classmates' names they can send the essay to any number of their classmates for peer editing or commenting. The methods of selecting portions of text for comment and for submitting comments are basically the same as under the teacher's view described above.

When a student views an essay that has been marked by the teacher, the essay itself appears almost identical to the student's original, unmarked essay. None of the teacher's comments are immediately visible. The only difference in the appearance of the marked and unmarked version of an essay is that in the 'corrected' version some of the student's text shows up in blue. These are portions of the essay that the teacher has marked for comment. To see the content of the teacher's comment, the student places the cursor on the blue text and the comment appears.

An important feature offered to students is a specific sort of search function which they can access through a link labeled: "Search all comments in my essays." With this function, a student can access a list of all of the comments that the teacher has marked on his essays. The comments are listed in descending order of frequency as they occur in the entire set of that particular student' s essays.

By clicking on the View button for any of these comments that appear on this display, the student retrieves a cumulative listing of all of the instances where this comment appeared in his own essays. To give the minimum context that would allow the student to see the nature of the marked problem, this search function retrieves complete sentences from the student' s texts even if the teacher had marked only a word or phrase or other proper subpart of that sentence for comment. In instances where the teacher has marked off a chunk of text which spans a sentence boundary in the student essay, the entire text of both (or all) of those sentences is displayed. By clicking on any of the tokens that have been retrieved, the student links to the complete text of the essay from which that token was extracted, thus accessing the full context.

What the "View Comments" function provides is the opportunity for the student to see patterns of difficulty, to see in one glance a set of tokens of one type of difficulty from his own writing. Of course, what is needed here is research on the differential effects of the two approaches to providing feedback. Moreover, the effectiveness of the View Comments function will almost certainly depend not simply on the fact that the system allows searches of the essays according to teacher comments, but also upon the quality and clarity of the comments themselves. An important property designed into the system is that it can track precisely the kinds of data needed for investigating these sorts of issues.

2.3 The Researcher' s View

The system has been designed to create a corpus of student essays as a byproduct of the teacher-student interaction on the system. Specifically, each essay that a student submits to his teacher over this system is, with the permission of that student, copied into a corpus of "learner English." Consequently the corpus itself grows as the system is used by students and their teachers.

The creation and analysis of corpora of learner language data is an extremely new and promising field of research (see Granger 1998). One of the formidable obstacles in this field is a practical one of how to input the learner data. Granger (1998:11) mentions three methods, all extremely tedious, time-consuming, expensive and the first two prone to error: (1) scanning essays from hard copies and (2) keying in data manually (3) downloading electronic data. Granger implies that the latter refers to collecting student essays that are on disks. Our system offers another way of creating learner corpora which goes a long way toward eliminating these prohibitive drawbacks. The texts created by students enter the corpus virtually unaffected by any intermediate steps for "inputting" them because the exact text that the student sends to the teacher over the system is copied into the corpus. Moreover, when students first register to use the system, they provide relevant metadata about their years of studying English, their gender, age, mother tongue, and the relevant fields of metadata are updated every semester. Each essay a student turns in is automatically indexed to this information and annotated with the date when that specific essay was submitted. This indexing allows for longitudinal studies of learner writing as well as cross-sectional studies that consider variables such as gender, age, or years of study. Researchers can add other fields of metadata to track other variables for specific studies.

Researchers are not only able to search the corpus of essays collected from learners. The results of the researcher' s analyses of learner difficulties can be translated into the content of an active online help function for those learners. The system includes an authoring environment for content administrators (ICPs) where they simply indicate what string of text in a learners essay should trigger help, and then write the content of the help which should be displayed for that particular string. Research on the learner corpus has revealed, for example, that the word 'ever' was misused by learners in 25% of the cases where it appeared in their essays. Further analysis attributed this to negative transfer in which learners associated the English expression 'ever' with a Chinese counterpart expression (*cheng jing*). These two expressions while overlapping in use and meaning, diverge in important ways, and it is precisely in these diverging respects where students misused the English expression. Based on this linguistic analysis, the authoring environment for online help was used to design advice concerning the word 'ever' addressing precisely the difficulties it poses for Chinese learners. When learners request general help on an essay, the help function actively detects instances of 'ever', highlights them

BEST COPY AVAILABLE

and creates a link to this advise.

3 Conclusion

The underlying goal of the project described above has been not only to create an online writing environment that connects teachers and students by way of a user-friendly interface, but also to provide ways to exploit the valuable data that is created when the environment is used. The learners' essays themselves are stored in growing corpus of ESL language production. The comments that teachers append to the particular segments of the learners' texts in the course of essay correction are treated as annotations of those texts, which can be searched and retrieved. An authoring environment for online help permits content administrators to turn interlanguage research results into highly specific help concerning attested difficulties which traditional language education has neglected. It is hoped that increasingly sophisticated and dynamic manipulations of these sorts of data will lead to the delivery of evermore useful and useable information to learners, teachers, and researchers both online and off.

References

[1] Chang, Hsiu-Chen, "Web-based EFL learning and teaching" (manuscript), (2000).

[2] Ferris, Dana, "The case for grammar correction in L2 writing classes: a response to Truscott" ,(1996). *Journal of Second Language Writing* 8-1:1-11, (1999).

[3] Granger, Sylviane, "The computer learner corpus: a versatile new source of data in SLA research.", In Sylviane Granger, *Learner English on Computer*. New York: Longman, (1998).

[4] James, Carl, "Errors in Language Learning and Use.", New York: Longman, (1998).

[5] Kearsley, G., "Computer-aided instruction, intelligent", In S. Shapiro (ed.) pp. 154-9, (1987).

[6] Kuo, C.-H., David Wible, and Chia-Lin Chio, "On the design of a synchronous virtual writing clinic." (manuscript), (2000).

[7] Kuo, C.-H., David Wible, Meng-Chang Chen, Li-Chun Sung, Nai-Lung Tsao, Chia-Lin Chio, and Chih-Chiang Wang "The design and implementation of an intelligent web-based interactive language learning system." (manuscript), (2000).

[8] Krashen, S., "The input hypothesis and its rivals", in Ellis, N. (ed.) *Implicit and Explicit Learning of Languages*, London: Academic Press, (1994).

[9] Ogata, Hiroaki, Yano, Yoneo, and Wakita, Riko CCML —"Exchanging marked-up documents in a networked writing classroom.", *Computer Assisted Language Learning*, 11-2:201-214, (1998).

[10] Nerbonne, John (ed), "*Linguistic Databases.* Stanford": CSLI, (1998).

[11] Neuwirth, M.C. and Wojahn, G.P., "Learning to write: computer support for a cooperative process.", In T. Koshmann, CSCL: Theory and Practice of an Emerging Paradigm. Lawrence Erlbaum Associates, pp.147-70, (1996).

[12] Selinker, L., "*Rediscovering interlanguage*.", London: Longman, (1992).

[13] Selinker, L., "On the notion 'IL competence' in early SLA research: an aid to understanding some baffling current issues.", In Brown, G., Malmkjaer, K. & Williams, J. (eds.). *Performance and competence in second language acquisition.*, Cambridge: Cambridge University Press, 92-113, (1996).

[14] Truscott, John, "The case against grammar correction in L2 writing classes.", *Language Learning* 46-2:327-369, (1996).

Integrating Web-based Materials into Course Design

Lilly Lee Chen
Rice University
6100 Main Street, Houston, Texas, USA 77005-1892
Tel: 713-348-2820
Fax: 713-348-5846
E-mail: Lchen@ruf.rice.edu

1 Introduction

This paper is a report on a project in which Web pages were crucially incorporated in the design of a new college course titled anguage and Culture in Taiwan." There were two main reasons for making the Internet an integral part of the course: (1) the wide range of topics covered in this very general introductory course requiring the wealth of information sources easily accessible on the Internet and (2) necessity of frequent updates of information due to the fast and volatile nature of the political evolution in Taiwan, particularly during the presidential election year when this course was offered. The consideration of user factors was also important. The Internet responds well to today's college students who demand relevance (of issues that pertain to the here and now) and immediacy, and are as adept in clicking on the keyboard surfing the Internet as flipping the pages of a book.

More serious, though, in our course design is the educational philosophy that a college's mission is not so much to transfer knowledge as to create environments and experiences that bring students to discover and construct knowledge for themselves [1]. Exposure to the vast amount of knowledge on the Web necessitates focus and careful choice of relevant materials. As part of course assignments students were expected to present on topics of their choice. This ensured that they researched the subject matters in greater depth before presenting them in class, as they would be presenting to an audience of their peers.

2 Method and content

The ready accessibility of the Internet for both the students (practically all students have a PC) and instructor (to add to or update the course page), especially outside of class, altered in-class activities from those of traditional teacher-centered instruction to student-centered discussion and presentation. The utilization of e-mail also facilitated out-of-class preparation. Students were informed by e-mail to go to a certain new site or link for a new development of events. Similarly, the student e-mailed the instructor for information or help. The more out-of--class preparations the students have, the better the quality of in-class discussions the instructor can expect.

The syllabus was essentially a structure of links organized according to the class schedule of topics and activities. It is also a display of the scope and structure of the contents of the course. It changed dynamically as new links were discovered and added throughout the semester. The syllabus appears as a navigation bar. To facilitate learning we have minimized visual search by displaying this syllabus bar consistently on top of each page[2]. Students can easily navigate from site to site, not only to preview but also to review. Besides a general page of topics with their links to available Web sites, the page of each session further highlights some particular links to topics of the session, along with a list of references available on reserve in the library.

The contents of this course consist of two major areas: (1) culture and (2) language. The former includes a wide range of topics, such as a profile of Taiwan, history, political parties, customs, festivals, family relations, literature, world view of Taiwan, and the future of Taiwan. Generally each topic or a group of related topics was covered at a weekly session, which lasted two and a half hours, of which the first half was devoted to cultural discussions and the second half, instruction of language. The culture part of the course was conducted in a seminar format along with presentations by students.

By dividing the content area into culture and language, we were not forgetting that language always operates in a culture [3]. Besides teaching phrases and sentences applicable in social situations, other aspects of the language, such as kinship terms, nursery rhymes, proverbs, songs, etc., abounding with traditions and cultural values, were also taught. The language part of the course contained sound files. Some had two types of reading, a slower one and a faster one, to facilitate learning. Taiwanese expressions in each language lesson generally contain both literal and free translations. This makes self-study very easy and convenient, as long as they could access the Web. Sound files were indispensable as Taiwanese is a tone language and furthermore has seven tones and possesses an elaborate tone sandhi system [4].

This Web program was produced entirely in the instructor's office by using Netscape Composer, SoundRecorder, and other freeware downloaded from the Internet [5]. The exercise part of the course, which features filling in of blanks, multiple choice, short answer, etc., was made possible by the ExTemplate program developed at Rice University Language Resource Center [6]. The ExTemplate application creates exercises that will be stored in a database for future retrieval [7]. It allows students to submit exercises via the Internet and be graded by the instructor also via the Internet. The language lesson sound files were integrated into ExTemplate. This feature was very useful particularly for tonal distinction exercises.

Our classroom was equipped with a multimedia Podium which allowed us to go on the Internet, show videos, movies, documents, play CD , etc. The Podium came in handy when a demonstration on the classroom screen was called for. Not only did the instructor use the Podium, students were encouraged to do their class presentations by using PowerPoint or by going to their own personal homepages where they collected Web links or images related to their topics for classroom presentation.

3 Conclusions

By incorporating the Internet into course design, we were able to create a more accommodating learning environment for the students and to give students more control over the learning process. As this was our fist attempt at teaching the course with Web-based materials, further refinements of many aspects of the course need to be made. For example, we can make pages less cluttered with text and add more digitized videos. Also researches can be conducted to determine students' reactions in terms of attitudinal factors and learning efficiency. Taiwanese on the Web is an on-going project. We solicit help and comments. This project attempts to raise awareness in the global community of the vitality of a culture less known and rarely covered in college courses. As universities generally suffer from budget constraints, by making this program available on the Web we hope to encourage teaching of this subject matter.

References

[1] Bar, Robert B., & Tagg, John, "From teaching to learning - a new paradigm for undergraduate education", Change 27-6 Nov./Dec., pp. 13-25, (1995).

[2] Aspillaga, M., "Screen design: Location of information and its effects on learning", Journal of Computer-based Instruction, 18(3), 89-92, (1991).

[3] Walker, G., & Noda, M., "Remembering the future: Compiling knowledge of another culture", Reflecting on the Past to Shape the Future, (eds.) Birckbichler & Terry, National Textbook Company, pp. 187-212, (2000).

[4] Chen, L., "Grammaticalization and Tone in Taiwanese", the 27th Forum of Linguistic Association of Canada and the United States (LACUS Forum 27), (2000).

[5] Chen, .L., Chang. J., Lai, S., & S. Yuen, S., "Web Based Instruction", Proceedings of the 8th International Conference of Chinese American Educational Research and Development Association (CAERDA2000), St. John's University, New York, September 16-17, (2000).

[6] Chen, L., Bartlett, C., & Verm, J., "ExTemplate: a tool for foreign language web editing", Proceedings of the South Central Association for Language Learning Technology (SOCALL 2000), Louisiana State University, Baton Rouge, Louisiana, April 7-8, (2000).

[7] ExTemplate Lesson Server: Online courseware authoring, http://lang.rice.edu/extemplate/, (accessed on August 1, 2000).

Is Everyone on Board: Learning Styles and the Internet

Michelle Hsiang*, Ellen Storey Vasu, Marsha Alibrand***, Nancy Atkins **** and Jane Steelman*******

** Research Triangle Institute/ NC State University. Email: mhsiang@rti.org*
*** NC State University. Email: esvasu@unity.ncsu.edu*
****NC State University. Email: marsh@cape.com*
*****NC State University. Email: atkinsn@he.orange.k12.nc.us*
******NC State University. Email: ravendoc@aol.com*

For many years, educators and practitioners have been implementing, enhancing and innovating variety of teaching methods to best fit students learning styles for eliciting the potential of students. As stated by Corno and Snow [2], "the success of education depends on adapting teaching to individual differences among learners", the teaching methods taught are to accommodate, meet, and elicit the diverse learning needs. Technology is becoming accessible to most segments of the United States population. As more and more classrooms are connected to the Internet and online-lesson plans are adopted to teaching and learning, it is important for teachers to ensure that the diverse needs of every student is addressed. This research study contained the quantitative analyses relative to learning styles and web design.

Keywords: **Humanities and Learning Technology, Instructional Design, Web-Based learning**

When computer technology increased its popularity in 1980's, Computer-Assisted-Instruction (CAI) in the form of drill, practice and tutorials was superior to traditional instruction [1] and outperformed those who received traditional instruction [7]. While providing feedback to reinforce learning in CAI, Pritchard [6] recommended that the use of computers in CAI require a specific learning style of paying attention to details for accuracy, so that students are able to work alone. Davidson et al [3] further examined learning styles and performance in computer concept and programming skills in BASIC, and found that learning styles had a significant effect on performance of a computer course. By 1997, 72% of the schools in the USA had online access. As teachers adapt their teaching to the use of the World Wide Web as a medium for resources, and to publish their class websites, the information delivery system has been changed from paper format to digital format and from fixed text to unlimited hypertext. The visual graphic representation has been switched from static to animated/multi-dimensional and from limited colors to millions of colors. With the advance of the technology, sound and movies can be incorporated into webpages to enhance teaching and learning environment. With the release of many HyperText Markup Languages (HTML) editors, e.g., Adobe PageMill, DreamWeaver, Front Page, it becomes very easy for anyone to create and publish webpages, therefore it is essential for educators to investigate the different learning styles of individual students when designing webpages.

Study Purpose and Sample Setting

The purpose of this study is to examine two different webpage designs regarding to students learning styles. A total of 44 students who enrolled college courses in graphic design, computer application and web design were selected in the study. Students in these classes had little or some knowledge of the Internet and Webpage design.

The two web designs were developed by the authors and used for the study: one-frame versus two-frame designs with the incorporation of colors, animation, buttons, and hypertexts. The one-frame design used a top-down sequential technique for web design. To begin, users must access from the main menu in order to navigate to other pages. The two-frame web design contained two displays located side-by-side. The left-frame normally contains the potential links, the right-frame displays the corresponding information. Users can make random selection of different links at any given time provided on the left-frame that served as the main menu.

Measurement and Procedures

In the beginning of the semester, the Gregorc Style Delineator [4] was administered and the scores were tallied to determine students prefer learning styles in (1) Concrete sequential; (2) Abstract sequential; (3) Concrete random; or (4) Abstract random. At the end of the semester, students were given an Uniformed Resources Links (URL) to review the two different styles of web designs as mentioned earlier. After review, an instruction was provided for the students to fill out an open-ended questionnaire to reflect their selection and to make their comments.

Selected Results:

Two-frame selection: Students preferred the two-frame design to the one-frame arrangement with a ratio of approximately 3:1. This again stressed the importance of design in CAI that emphasized gaining attention, guiding learning, informing learners of objectives, and presenting stimuli with distinctive features. The reasons why users were in favor of the two-frame design included that it was easier to navigate with left-frame controlling the right-frame. With all the links listed on one-frame and information displayed on the other, it provided a quick access to the viewer.

One-frame selection: Students who preferred the one-frame design to the two-frame one like the fact that it was easy to follow and less confusion, simple but effective. Information straight down on a page was easier to read and to understand than a two-frame design. It kept attention intact and was readily for research. Some found that it was easy to use for computer illiterate people.

Discussion

The two-frame design is a newer approach than the single frame design. Students used to the one-frame design and some still prefer the same way of accessing information, even though the two-frame design has pleasing results and is reportedly easier to use than the one-frame design. In summary, this research suggested that the major reasons why the students disliked the two-frame design were because they were simply unfamiliar with the structure. Additional training and more exposure to the two-frame design would help them overcome the barrier. As the popularity of the Internet increases and the HTML editors become easier to use, it is important to emphasize these design factors, so that the webpages can be designed more accessible and user friendlier as technology advances.

Reference

[1] Burns, P. K. & Bozeman, W. C. (1981). Computer Assisted Instruction and Mathematics Achievement: Is there a Relationship? Educational Technology, 21, 32-37.

[2] Corno, L., & Snow, R.E. (1986). Adapting teaching to individual differences among learners. In Handbook of research on teaching, 3rd ed. Ed. M.C. Wittrock, New York: Macmllan.

[3] Davidson, G., Savenye, W., & Orr, K. (1992). How do learning styles relate to performance in a computer applications course? Journal of Research on Computing in Education, 24, 348-358.

[4] Gregorc, A. (1976). Learning Styles Inventory. Storrs: University of Connecticut.

[5] Kulik, J., Bangert, R. & Williams, G. (1983). Effects of Computer-Based Teaching on Secondary Students. Journal of Educational Psychology, 75, 19-26.
[6] Pritchard, W.H. (1982). Instructional Computing 2001: A Scenario. Phi Delta Kappan, 65, 322-325

Learner Control in Technology-mediated Learning within a Constructivist Model

Manuela Perez and Jun H. Jo
School of Information Technology
Faculty of Engineering and Information Technology
Griffith University, Gold Coast, QLD, Australia
PMB 50 – Gold Coast Mail Centre
QLD 9726 – Australia
Tel: + 61 7 5594 8266
Fax: + 61 7 5594 8066
E-mail: M.Perez@gu.edu.au and J.Jo@gu.edu.au

This paper explores current strategies on learner control within a technology-mediated learning environment, with a special emphasis on constructivism as the underlying learning theory. An adaptive learning model, based on constructivism is presented. The model addresses the issues of learner control and its implementation within a technology-mediated learning environment. The model's major components: Learner module, Designers module, User Control Manager module, Cyber Classroom module and the Analyser module are outlined and analysed. The aim of the model is to offer an adaptive learning system that caters for different types of learners and learning styles, with an especial emphasis on learner control. The model empowers the learners and provides them with the means for constructing and re-constructing knowledge at their own pace within a constructivist framework that is learner centred and flexible. We propose a system that is dynamic and merges the capacity to deliver educational material with the ability to analyse learners performance, based on navigational patterns and results, and system performance in order to either advise and guide the learner or to modify learning materials or their presentation.

Keywords: **Learner Control, Technology-mediated Learning, Constructivism, Technology-mediated Adaptive Learning Model.**

1 Introduction

Technology has impacted greatly on education. Since the introduction of technology, new delivery methods, as well as new challenges, have emerged. One of the most important delivery methods introduced has been flexible delivery or flexible learning as it is now preferably called. Flexible learning is learning that can be achieved at your own pace and independently of time and place. Several technology-mediated approaches, for example, Web Based Instruction (WBI) and Competency Based Instruction (CBI), have been used to provide the flexibility required to deliver flexible learning.

Technology-mediated learning is versatile. It can be used as the only means to deliver education or as an aid to traditional up-front teaching. Although technology has been embraced by education, there are areas of concern over its use, or more precisely, over its misuse. Areas of concern include: access to the medium, measurement of students learning, testing the validity of the Internet as an instructional medium and the cost of producing technology-based learning materials (Rickard, 1999; Eckert *et al.*, 1997). Selwyn (1996) points out that the Internet can become a trap for both teachers and students as it can go from the '*tool to the toy*' in education if its use is not properly guided and monitored. Phillips (1980) also expresses concern about the quality of on-line materials on the Internet. In spite of these issues the proliferation of courses designed and developed for a technology-mediated environment continues to increase.

This paper explores current trends on technology-mediated learning environments with an especial emphasis on learner control. The paper also proposes an adaptive learning model based on constructivism. The model addresses the issue of learner control and its implementation within a technology-mediated learning environment.

2 Technology and learning control

A technology-mediated environment offers the learner a number of choices and alternatives that were inconceivable in a traditional educational setting. Traditional education, both on-campus and distance learning, is highly structured, teacher centred, mostly one-way communication and directed to passive learners. In contrast, technology-mediated learning, within a constructivist approach, can be learner centred, unstructured to suit the learner's individual learning needs and context-based. It also allows the learner to take control of the learning process, promotes social discourse and collaboration and contributes to the personal growth of the learner.

2.1 Learner Control in Technology-mediated Learning

The definition of *learner control* often appears to be elusive. In its broadest sense, learner control refers to the level of self-determination that the learner has in making decisions about his/her learning (Doherty, 1998). Learner control is often being addressed in combination with other factors. For example, learner control and attitude towards the technology-based system used (Ivanoff and Clarke, 1996; Mitra, 1997) and learner control and epistemic beliefs (Jacobson, *et al.,* 1996). Learner control, within the scope of this paper, refers to the degree of autonomy that learners have in organising, pacing, sequencing and using the available learning resources. That is, the ability and power of adapting the technology-mediated environment to suit their individual specific learning needs. Control over their learning direction and pace is made possible by the many alternatives and choices that a technology-mediated learning system offers the learner (Bagui, 1998). The level of control that the learner needs to exert over the learning environment is not constant over time. Learners will engage in different levels of control depending on their individual learning style (Rasmusen and Davidson-Shivers, 1998), prior knowledge of the material or related material (Fitzgerald and Semrau, 1998), attitude towards information technology (Ivanoff and Clarke, 1996; Mitra, 1997) and past experience, initiative, intellectual and social maturity, metacognitive proficiency, and insights (Ewing *et al.,* 1998).

2.2 The role of the teacher in Technology-mediated Learning

Frank Wydra anticipated a learning environment in which the teacher's role focus changed from delivering instruction to designing the instruction (Wydra, 1980). By the hand of technology we may transform the teacher from the "*sage on stage*" to the "*guide at the side*" (Andrews, 1997). Within a technology-mediated learning environment, the educator's role, far from becoming redundant, metamorphoses into a more challenging and active one. The educator becomes the leader, designer and manager of the learning environment (Doherty, 1998). Other vital functions are initiating the learning process; supporting, encouraging and motivating the learner and mediating between the learner, the technology and the resources (*Ewing et al., 1998*).

The new role of the teacher, in technology-mediated learning, is a very demanding one. *Ewing et al.,* (1998) emphasise the great deal of effort that goes into planning and preparing technology-mediated learning materials and environments. The design and development of multimedia teaching material, especially for distance education, is a time-consuming process. For one hour of CBT software approximately 200 hours of development time are required (Kawalek, 1995). The educator's role does not stop after the planning, designing and preparation of the technology-based materials. It must also facilitate the learning, monitor learners' progress and evaluate the performance of the system, the learners' and his/her own in order to further improve the system. "*The need for the teacher does not go away*" in a technology-mediated environment with emphasis on learner control (Andrews, 1997).

3 Constructivism

The introduction of technology-mediated learning has called for a revision of learning strategies.

Constructivism is gaining momentum and has been heralded as the most appropriate learning theory for the technological classroom. Constructivism was introduced by Piaget's and Vygotsky's learning theories. Piaget's learning theory involves two cognitive stages: assimilation and accommodation (West *et al.*, 1991). During the assimilation stage the learner attempts to fit the environment with existing mental schemata. The accommodation stage is reached when the learner is confronted with a new experience, for which no schemata exists, or one exists but does not conform to the new experience. As a result, equilibrium occurs when, through an alternate process of assimilation and accommodation, the learner achieves cognitive stability. Externally in-coming experiences find a corresponding mental schemata and the learner is aware of this fact. In order to achieve high-level cognition the learner must be aware that learning has indeed occurred. Otherwise, learning will stop at the behaviourist level where it is ascertained by an external party, usually the teacher, or in the case of a technology-mediated environment by a computer program.

Vygotsky's learning theory differs from Piaget's in that he sees learning taking place within a social and cultural context. He argues that social interaction affects the way the learner sees the world. That is, it contributes to the way the learner constructs his/her schemata. Therefore, the quality of the learning will be determined by the quality of the social interactions or what Vygotsky terms *zone of proximal development* (Oliver, *et al.*, 1997).

In a learning environment the cultural and social interactions translate to interactions between teachers and peers. Within this collaborative learning environment the teacher becomes the facilitator of learning. The facilitator's role should be to design, promote and guide the learning but not to enforce it as learning is an individual process. Knowledge in this environment is socially constructed and has no absolute value but a socially agreed value.

4 The proposed learning model

The aim of the proposed model is to offer an adaptive learning system that caters for different types of learners and learning styles with an especial emphasis on learner control. The proposed model operates within a constructivist approach to learning (Ewing, *et al.*,) based on the following points:

1. **All learners are different**
2. **Learning is individual to each learner**
3. **A learner can learn at different speed levels in different situations**
4. **A learner can engage in different learning strategies simultaneously**
5. **Learners learn best with a context**
6. **Learners construct and re-construct knowledge as they seek to understand and explain their environment**

4.1 Proposed model learning variables and controls

The concepts of learner individuality and learner control are essential to constructivism. Table 1 below depicts the main variables involved in the proposed model in relation to learning control and learners' choices and options.

VARIABLES	CONTROLS	
	INSTRUCTOR	LEARNER
Learning Objectives	Overall	
Amount of information provided	Overall	
Amount of information used **Addition/removal of material**		Desirable
Material appearance and mode		Desirable
Pacing, time	(When necessary)	Desirable
Sequencing	(When necessary)	Desirable
Place, location		Desirable
Monitoring learners' individual progress	Overall	
Interaction and collaboration	Shared	Shared
Assessment	Overall	

Table 1. Control Variables and Controllers

The term ***desirable***, rather than ***overall***, is used in the learner control column because the proposed model's aim is to empower learners not to force them to take control. For example, a learner that possesses prior knowledge of a topic is more likely to exercise control over his/her learning than a novice learner is. The second is more likely to follow a linear approach to learning until he/she too acquires prior knowledge.

Learning objectives

Learning objectives within the model are explicit, clearly specified and achievable. The acquisition of non-anticipated learning objectives is possible within the system, especially, when the learner accesses more information that is required to complete a task. This is a positive feature of the model as far as the specified learning objectives have been reached.

Amount of information provided and used

The system contains all the information necessary to achieve the specified learning objectives or provides references to acquire it. However, the learner controls the amount of information that is actually used. A learner can discard a particular learning material piece in favour of another, which has been acquired from external sources, just because is easier to understand or is visually more appealing. Learners' performance can be improved by designing materials that can be adapted to satisfy different learning styles (Rasmussen and Davidson-Shivers, 1998).

Learning material appearance and mode

A genuinely adaptive technology-mediated learning system must allow learners to customise the appearance and mode of the material displayed. This may include: changing background and text colours and choosing between text, graphics, audio and video modes.

Pacing and timing

The learner has the autonomy of pacing his/her learning and scheduling his/her study time. However, in some instances this has to fit within the general time-frame allocated to the course or subject. The designer controls the general time-frame, if one exists.

Sequencing

Learning materials must be accessed in the order that most benefits the learners' learning style. The model is able to cope with the demands of linear as well as non-linear approaches to learning. Figure 1 displays an example of the progression or navigation path of a learner who prefers to be guided by the system. '*Learner 1*' uses all the material provided and in the order provided until she encounters difficulties and seeks the help of an instructor or other learners. Then, revises the previous lesson and again continues with the linear path provided. In contrast, '*Learner 2*' feels confident enough to discard material provided and adds material from external sources. Both learners achieve the corresponding learning objectives through the use of different learning strategies. Beginners often benefit from having a structured learning path (Eaton, 1996). A graphical representation or map of the entire unit or lesson must be made available to the learners to guide their navigation decisions (Barba, 1993).

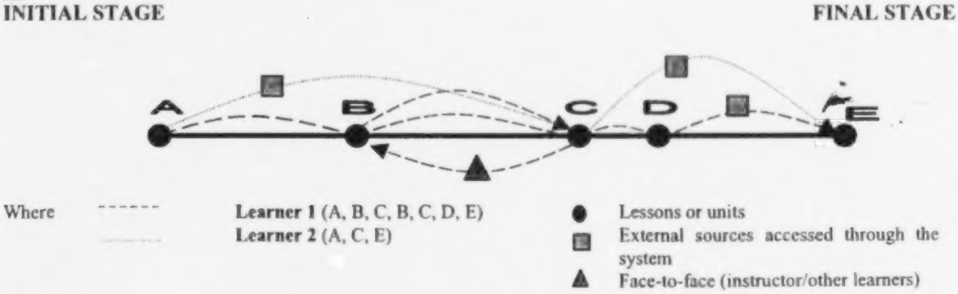

INITIAL STAGE
FINAL STAGE
A
B
C
D
E
Where ------
Learner 1 (A, B, C, B, C, D, E)
Learner 2 (A, C, E)
Lessons or units
External sources accessed through the system
Face-to-face (instructor/other learners)

Figure 1. Learning Sequence Patterns – Linear and Non-linear

Learners must be free to use forward and backward navigation through the system as long as it does not compromise the learning itself. For example, if the completion of a task is the pre-requisite for another, allowing the learner to move onto a task for which a pre-requisite has not been completed might result in a waste of time and unnecessary added frustration for the learner. For example, moving into algebra without knowing how to multiply.

Place and location
Technology-mediated learning offers the possibility of accessing and using learning materials at different locations. Using the proposed model, learners can now study at home, at appropriately equipped learning centres or at traditional classrooms.

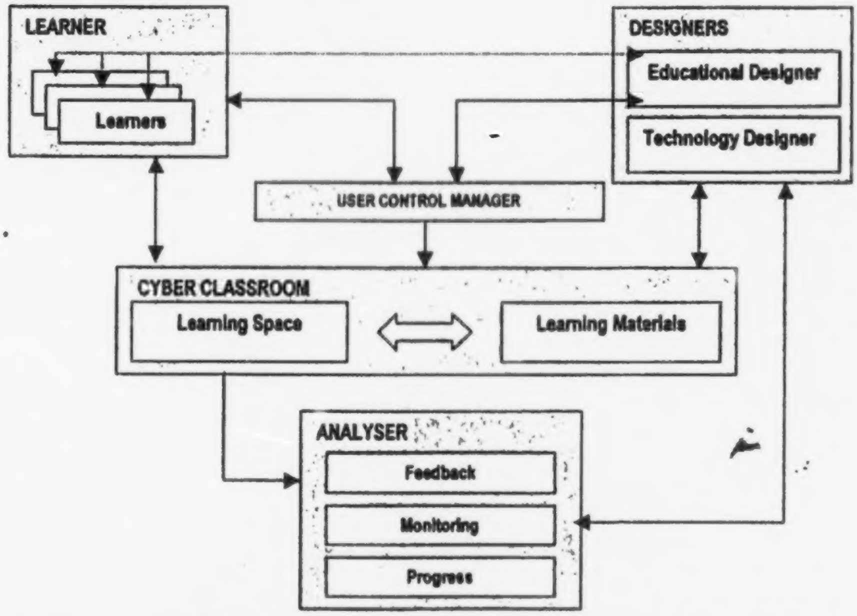
Monitoring learners' individual progress
Instructors are in control of monitoring the learners' individual progress. Based on the analysis of the learners' performance instructors can either guide or advise the learners through different strategies or modify the system.

Interaction and collaboration
The system must provide the capabilities to allow learners to interact with each other and with their instructors. This communication may occur, for example, through e-mail, and on-line forums. Physical, or face-to-face, communication is also a part of the model.

Assessment
Assessment is designed and administered by the instructor. This is to evaluate the students' learning performance and to provide feedback both to the educator and to the students.

4.2 Technology-mediated Adaptive Learning Model

The proposed model, the Technology-mediated Adaptive Learning (TAL) model, is composed of five modules: Learner module, Designers module, User Control Manager module, Cyber Classroom module and Analyser module, Figure 2.



Where → Technology-mediated communication (web browsing, down/uploading, email, forum, database updates, ...)
→ Physical communication

Figure 2. The Technology-mediated Adaptive Learning (TAL) Model

4.2.1 Learner Module

The learner module comprises the learner group. Learners interact with the TAL system through the Learning Space. Communication with instructors and other learners occurs within the Learning Space or physically, as indicated by the dotted line in Figure 2.

4.2.2 Designers Module

The designers' module can be composed of an educator, instructional designer, multimedia designer and technicians. This module is concerned with three main areas: the educational design, multimedia design, and computer and Internet technology. The educational designer is in charge of designing quality learning materials within a constructivist approach. This includes being aware of the subject matter as well as the pedagogical theory in use. The multimedia designer and the instructional designer help the educator to appropriately formulate the teaching materials for CBI or WBI. The technology designer provides the means to make the learning materials available to the learner group through a technology-mediated environment. Good skills and tools for multimedia authoring and technical services are required in this module, which may cause production cost issues.

4.2.3 User Control Manager Module

The User Control Manager allows the learner to customise the learning space. Through this module the learner can select the display mode to suit his/her own learning needs and preferences, for example, text, graphics, audio or video mode. Pacing and sequencing of the learning material can also be controlled from this module.

4.2.4 Cyber Classroom Module

The Cyber Classroom module is composed of two sub-modules: Learning Space and Learning Materials module. The Learning Space is where the learning is delivered. This is generally a kind of display unit, such as a personal computer or a network terminal screen. It may also include equipment for sound and video. It must be easy to interact with and be self-explanatory. Within the Learning Space the learner has the option of accessing learning materials provided by the educator, such as lecture notes, or external resources such as Internet sites or libraries

4.2.5 Analyser Module

The purpose of the analyser module is three-fold. First, it gathers statistics on the performance and progress of learners. Second, it records learners' perceptions about the learning material presented and about the overall working of the system (learner feedback). Finally, it monitors and records students' navigation patterns into a database. These will provide an indication of the learners' preferred learning styles. This information can be used to provide advice for the learner and to improve the system (Chavero *et al.*, 1998) by evaluating the existing materials and options and formulating new ones. The optimal implementation of the system will be to incorporate an Intelligence module to automatically generate and administer changes, based on the information within the database.

The TAL model is being implemented in a couple of different programming languages and database tools.

5 Reviewing learner control, constructivism and the TAL model

5.1 The TAL Model and Learner Control

The main objective of the model is to provide a technology-mediated learning system able to support learner control within a constructivist approach. The learner control variables, identified in Table 1, have been built into the model. Learning objectives, amount of information provided, monitoring of learners individual progress and assessment are overall controlled by the instructor, while the amount of information used/added/removed, material appearance and mode, pacing, timing, sequencing, place and location are potentially controlled by the learners. Interaction and collaboration can be initiated by either party as the need arises.

5.2 The TAL model and Constructivism

The underlying pedagogical theory governing the TAL model is based on constructivism, and specifically on the constructivist elements represented in the table below. The model addresses all elements, however, its concrete effectiveness will only be determined after development and implementation, in practice.

TAL Constructivist Approach Checklist	
EXPECTED CONSTRUCTIVIST ELEMENTS	**TAL MODEL**
• All learners are different	The model allows for learner differences in needs, learning styles, and skills.
• Learning is individual to each learner	Learners can customise the learning materials to suit their learning styles and needs through the User Control Module.
• A learner can learn at different speed levels in different situations	Learners can control pacing and sequencing of learning materials.
• A learner can engage in different learning strategies simultaneously	Learners can engage in linear and non-linear strategies. Also they can learn independently and/or seek collaboration.
• Learners learn best within a context.	Learning materials (provided by the TAL model) are always presented within a context.
• Learners construct and re-construct knowledge as they seek to understand and explain their environments	This feature is intended within the model but only after implementation will it be ascertained.

Table 2. TAL Constructivist Approach Checklist

6 Conclusion

This paper has addressed current educational trends on learner control within technology-mediated learning environments. The roles of the learner and the teacher have been reviewed and analysed in the light of technology-mediated environments.

The TAL model, based on constructivism, was presented, and its major functions were explained. The model includes five modules: Learner module, Designers module, User Control Manager module, Cyber Classroom module and the Analyser module. The aim of the model is to offer an adaptive learning system that caters for different types of learners and learning styles, with an especial emphasis on learner control. The model presented, empowers the learners and provides them with the means for constructing and re-constructing knowledge at their own pace within a constructivist framework that is learner centred and flexible.

From the designers point of view the model is a dynamic system that merges the capacity to deliver educational material with the ability to analyse learners performance (based on navigational patters and results) and system performance in order to either advise and guide the learner or to modify learning materials or their presentation.

References

[1] Andrews, E.A., A non-euclidean view of teaching, *Proceedings of ED-MEDIA 97 & ED-TELECOM 97*, Canada, (1997).

[2] Bagui, S., Reasons for increased learning using multimedia, *Journal of Educational Multimedia and Hypermedia*, **7**(1), 3-18, (1998).

[3] Barba, R.H., The effects of embedding an instructional map in hypermedia courseware, *Journal of Research in Computing and Education*. **25** (4), 405-412, (1993).

[4] Chavero, J., Carrasco, J., Rossell M.A. and Vega, J.M., A graphical tool for analysing navigation through educational hypermedia, *Journal of Educational Multimedia and Hypermedia*, **7**(1), 33-49, (1998).

[5] Doherty, P.B., Learner control in asynchronous learning environments, *ALN Magazine*, **2**(2), (1998). URL:http://www.aln.org/alnweb/magazine/vol2_issue2/doherty.htm.

[6] Eaton. M., Interactive features for HTML-based tutorials in distance learning programs, *AusWeb96*, (1996). URL:http://elmo.scu.edu.au/sponsored/ausweb96/educn/eaton/paper.html

[7] Eckert, A., Geyer, W. and Effeldberg, W., A distance learning system for higher education based on telecommunications and multimedia: A compound organisational, pedagogical, and technical approach, *Proceedings of ED-MEDIA 97 & ED-TELECOM 97*, Canada, (1997).

[8] Ewing, J.M., Dowling, J.D. and Coutts, N., Learning using the World Wide Web: A collaborative learning event, *Journal of Educational Hypermedia*, **8**(1), 3-22, (1998).

[9] Fitzgerald, G.E. and Semrau, L.P., The effects of learner differences on usage patterns and learning outcomes with hypermedia case studies, *Journal of Educational Multimedia and Hypermedia*, **7**(1), (1998).

[10] Ivanoff, G. and Clarke, J., The use of the world wide web for teaching: things to consider before putting materials on-line, *Australian Communication Conference: Teaching Communications Skills in a Technological Era*, Monash University, Australia, (1996).

[11] Jaconson, M.J., Maouri, C., Mishra, P. and Kolar, C., Learning with hypertext learning environments: theory, design and research, *Journal of Educational Multimedia and Hypermedia*, 5(3/4), 239-281, (1996).

[12] Kawalek, J., in (Eckert, A., Geyer, W. and Effeldberg, W. (1997). A distance learning system for higher education based on telecommunications and multimedia: A compound organisational, pedagogical, and technical approach, *Proceedings of ED-MEDIA 97 & ED-TELECOM 97*, Canada), (1995).

[13] Mitra, A., Categories of computer use and their relation with attitude toward computers, *Proceedings of ED-MEDIA 97 & ED-TELECOM 97*, Alberta, Canada, June, (1997).

[14] Oliver, R. and Omari, A. and Herrington, J., Exploring student interactions in collaborative world wide web learning environments, *Proceedings of ED-MEDIA 97 & ED-TELECOM 97*, Canada, (1997).

[15] Phillips, R., What research says about learning on the Internet, *in* C. McBeath, C. McCoughlin and R. Atkinson (*eds.*), *Planning for Progress, Partnership and Profit, Proceedings EdTech'98*, Australian Society for Educational Technology, Perth, (1998).
URL:*http://cleo.murdoch.edu.au/gen/aset/confs/edtech98/pubs/articles/p/phillips.html.*

[16] Rasmusen, K.L. and Davidson-Shivers, G.V., Hypermedia and learning styles: can performance be influenced? *Journal of Educational Multimedia and Hypermedia*, 7(4), 291-308, (1998).

[17] Rickard, W., Technology, education, and the changing nature of resistance, *EDUCAUSE, Educom Review*, Vol. 34 (1), 42-45, USA, (1999).

[18] Selwyn, N., The Internet and schools: An uneasy alliance? *Compute-Ed*, Vol 4, (1998).
URL: *http://www.edication.uts.edu.au/projects/comped/Vol4/selwyn.html.*

[19] West, C. K., Farmer, J.A. and Wolff, P.M., Introduction to Cognitive Science and instructional design, *Instructional design: implications from a Cognitive Science*, pp.3-27, Allyn and Bacon, Sydney, (1991).

[20] Wydra, F.T., Learner controlled instruction, *Englewood Cliffs, Educational Technology Publications*, New Jersey, (1980).

LEARNERS' STRUCTURAL KNOWLEDGE AND PERCEIVED DISORIENTATION IN A HYPERMEDIA ENVIRONMENT: THE EFFECTS OF INFORMATION CONVEYING APPROACHES AND COGNITIVE STYLES

Jim Jiunde Lee
Department of Mass Communication, Chinese Culture University, Taiwan
jiulee@giga.net.com

The flexible nature of hypermedia allows it to be tailored to an individual' s needs. Despite the many degrees of navigational freedom, however, users of hypermedia often find difficulty locating information, feel disoriented, or even become "lost in hyperspace" within such large seas of data. Research findings suggest that the disorientation problem could be solved if users are able to hold a conceptual overview of the hypermedia structure. How a learner can acquire correct structural knowledge of the information becomes an important issue to affect their learning performance in a hypermedia environment. Variables such as the different ways of structuring or conveying information and cognitive styles may affect learners' cognitive abilities in knowledge structuring and should be taken into account together. The results of this study will show whether the interactions between information conveying approaches and learners' cognitive styles have significant effects on learners' performances in terms of structural knowledge and feeling of disorientation.

Keywords: **Structural knowledge, Cognitive style, Concept map, Disorientation, Hypermedia**

1 Introduction

One of the recent developments in computer technology now applied in many educational institutions is the technology of hypermedia (Liu & Reed, 1994; Paolucci, 1998), in which users can access specific information by various paths. The flexible nature of hypermedia allows it to be tailored to an individual' s needs. Reading in hypermedia allows more random access and offers overt ways of accessing (Tierney, 1994). However, users of hypermedia often experience difficulty locating information, feel disoriented, or even become "lost in hyperspace" (Elm & Woods, 1985) within such large seas of data. Scholars (Beasley & Waugh, 1995) have suggested that the disorientation problem could be solved if users are able to hold a conceptual overview of the hypermedia structure. In other words, if users can substantially construct a structural knowledge (Jonassen, Beissner, & Yacci, 1993) of the information provided in the hypermedia system, their learning performance could be improved.

Ways to structure or convey information in the physical sense should not be the only concern when the instructortry to facilitate the formation of the learner's structural knowledge. Factors such as learners' characteristics that could affect their cognitive abilities in knowledge structuring should also be taken into account. Few studies have been conducted in this domain. The purpose of this study is to investigate learners' cognitive characteristics in the dimension of cognitive styles and their effects on the acquisition of structural knowledge through the application of different information conveying approaches: the Less Explicit approach and the More Explicit approach.

2 Background of The Study

Learning is a process of reorganization of knowledge structure. Based on the concept of meaningful learning (Ausubel, 1963), in one way, learners structure knowledge to serve as a framework that helps them to associate new information with previous knowledge. As this framework becomes more complex, learners may in turn rely on this conceptual structure to filter the important from the irrelevant points (Anderson, Reynold, Schallert, & Goetz, 1977). The acquisition of correct structural knowledge has become a critical issue in learning. Among other computer technologies, hypermedia is a potential tool to mediate the structural knowledge of the target domain to learners. One of the current theories about mind structure, the "mind as rhizome" (MAR) metaphor (Eco, U., 1984), hypothesizes that the human mind is organized like an underground rhizome. Hypermedia tangibly simulates the learning assumptions of this mind metaphor in that learners can filter, link and search for new or existing information. These features have made hypermedia an ideal environment where experts' knowledge structures are made visible and navigable for learners in a graphical or a textual form (Wilson & Jonassen, 1989). Compared with novice users of a subject domain, expert users in this domain are believed to possess a better knowledge structure that enables them to effectively solve problems. The learning strategy of externalizing experts' knowledge structures to provide "idiosyncratic" intellectual thinking (Schwen, Goodrum, & Dorsey, 1993) has been deemed a pragmatic way to empower learners.

In comparing hypermedia with linear text in book-bound printed material, Conklin (1987) noted that any piece of text that the user wishes to locate in a book can only be further forward or further back from where the user is currently located. Hypermedia, on the other hand, is often designed to store or to locate information in a non-linear manner. Instead of a long run of narrative text on sequentially numbered pages, hypermedia is typically organized into small segments of text and learners control the reading flow of the materials (Berk & Devlin, 1991). Regardless of claims about the benefits of using hypermedia, however, Charney (1987) and Dias & Sousa (1997) pointed out that the ordering of topics and points as well as various traditional orientating devices, such as overviews and summaries which are usually taken for granted in books and papers, are non-existent in hypermedia. Without such orientating devices or narrative cues, and lacking the knowledge of hypermedia structure, users can barely determine where they are, what they want, and how to get there (Beasley, 1994; Tripp & Roby, 1990). These issues raise a number of questions. Is knowledge of the material' s structure as important as scholars suggest? Can one attempt to represent the structure of a document cognitively, and if so, what form might it take?

3 Theoretical Framework

Learning in Hypermedia

Hypermedia is a developing concept that perhaps first originated with Bush (1945), who envisioned a text that was organized like the human mind. Unlike a traditional learning environment, hypermedia mainly relies on self-directed learning. With this system, the responsibility for identifying what is useful information and the selection of search strategies for locating that information are largely left to the user (Small & Grabowski, 1992). Instead of having an instructional-base, like conventional Computer-Based Instruction (CAI), the format of hypermedia is information-based. CAI materials normally include objectives, presentation of information, and drill-and-test activities (Gange, 1976). These materials lead users to engage in intentional learning, in which all learning activities are arranged to accomplish the pre-determined learning goal.

Conversely, the learning that occurs in hypermedia is a type of incidental learning: the instructional content is provided without a specific learning goal (Spiro & Jehng, 1990). Learners in a hypermedia environment are encouraged to interact with and explore the information by developing their own paths or knowledge structures.

Although hypermedia has had remarkable impacts (Jonassen & Grabinger, 1990; Mcaleese, 1991) on human learning modes, accessing immense amounts of information within a hypermedia system is often not an easy task, especially for novices. As Hammond and Allinson (1989) indicated, people may encounter a number of common problems when they use hypermedia. They may have difficulty using interface tools in order to gain an overview and to locate specific information; they are also likely to wander without a strategy or goal and finally get lost. It is necessary that we investigate what types of cognitive characteristics might affect learners' performances involved in hypermedia learning and how hypermedia can thus be customized to fulfill learners' cognitive needs.

Hypermedia and Cognitive Styles

Hypermedia appears to be an ill-structured and non-linear type of conceptual networking environment. It seems to avoid prescribing a particular path for navigating information. Such a structure could be questionable for a learner who is in need of guiding pathways. A learner's performance in hypermedia may be affected by his / her individual cognitive style. Many variables, such as age, motivation, cognitive style, and prior knowledge / experience with the system (Heller, 1990; Lai, 1994; McAleese, 1989; Paolucci, 1998; Rhee, 1993) have been proven to be influential factors in the user' s performance. Some of these studies were conducted in a conventional computer-based instruction environment. In those that were conducted in a hypermedia environment, cognitive style was found to be an essential factor in learning (Chang, 1995). Research findings support this notion that individual cognitive differences affect learning results among adults (Davidson, Savenye, & Orr, 1992; James & Blank, 1991). Understanding these differences can help instructors cope with the variations in performance exhibited by their students (Moore, 1994).

Cognitive style refers to a learner' s information processing habits, this being manifestly reflected in his / her perceptual ability and in personality as well (Greco & McClung, 1979; Witkin, et al., 1977). It is "a superordinate construct involved in many cognitive operations that accounts for individual differences in a variety of cognitive, perceptual, and personality variables" (Vernon, 1973, p.141). There are no good or bad cognitive styles. They could only to be described as effective or ineffective in terms of their influence on a specific task (Strother, 1982). Studies on cognitive styles initially stemmed from the field of individual differences. These issues were extensively studied during the 1960s and remained popular in the early 1970s, but have since tended to fade out. As Riding and Cheema (1991) stated, this decline left the whole field of exploration fragmented and incomplete. In spite of their attracting little interest in the last two decades, cognitive styles are now once again being considered more seriously by scholars due to the coming of hypermedia technology.

In this research proposal, cognitive style will be examined in the two dimension of Wholist / Analytic and Verbal / Imagery. After reviewing work on the cognitive style study, Riding and Banner (1986) found that there was an interaction effect between Field-dependence / independence style and verbal / imagery style on the learner' s performance. Riding and David (1991) concluded that the Group Embedded Figures Test (GEFT)(Witkin, 1962) that has frequently been used to identify Field-dependence / independence style has limitations. In order to overcome some weaknesses of the traditional method for assessing Field dependence / independence like GEFT (e.g. Witkin, 1962), the Cognitive Styles Analysis (Riding, 1991) was developed. This approach classifies learners' cognitive behaviors into four different categories: Wholist-Verbaliser, Wholist-Imager, Analytic-Verbaliser, and Analytic-Imager. In this classification, Riding felt that for educational and training purposes it is more meaningful to term Field-dependent as Wholist and Field-independent as Analytic. The Wholist trainee tends to view the information in whole and the Analytic trainee tends to separate out the individual parts of information. Riding method differs from GEFT in four significant ways. First, it positively measures the wholist tendency and does not simply assume that if a person does poorly on a disembedding task that they are Field-dependents. This overcomes a major objection to the notion of Field-independence being a learning style raised by those who have argued that since generally Field-independents are superior to Field-dependents, it is simply a correlate of intelligence or general ability. Secondly, it compares a person' s relative performance on the to halves of the continuum. Thirdly, by using computer presentation, it allows more sensitive timing of the task. And finally, Riding' s Cognitive Styles Analysis refines the GEFT method and incorporates the assessment of the second fundamental dimension: Verbal-Imagery cognitive style. The Wholist-Analytic (Field-dependence-independence) / Verbal-Imagery classification is considered to be particularly valuable when it is used to examine different learners' behaviors in a non-linear environment such as hypermedia (Roberston, 1982; Riding, 1997). These two dimensions of cognitive styles that reflect on learning involve the various cognitive restructuring skills and analyzing ability for incoming information that are especially demanded in an ill-structured environment such as hypermedia. It is likely that the best performance on learning task comes from combinations of these two style dimension that offer the greatest strengths, namely Wholist-

Verbalist learners and Analytic-Imager learners, whereas Wholist-Imager learners and Analytic-Verbalist learners are less complementary and might result inferior performances.

Hypermedia and Structure Knowledge

According to Conklin (1987), disorientation is one of major problems for hypermedia systems. Elm and Woods view this "disorientation" in terms of degradation rather than as a subjective feeling of being "lost". One of the assumptions in their 1985 study about users' performance is that users might attempt to create a comprehensive cognitive map of the knowledge domain. The problematic issue of getting lost in a display network is caused by the user lacking a clear conception of the relationships within the system, or as Jonassen, Beissner, & Yacci (1993) call it, *Structural knowledge*. Structural knowledge is a memory / cognitive structure, a collection of bits of information and relationships among concepts. It could also be termed the internal structure (Korthauer, R. D & Koubek, R. J., 1994), which refers to the knowledge structure of users who are experienced in the domain, and to a type of mental model that users must create and bring to bear as they work in an electronic information space (diSessa, 1986; Gentner & Stevens, 1983; Russell, 1986). The acquisition of structural knowledge, according to Ausubel (1963), involves the linking of new information to existing information, which results in a dynamic framework of knowledge. That is, through the information processing procedure, learners experience new information and refine or reconstruct their knowledge frameworks as needed.

In hypermedia, there are two approaches to help learners construct their structural knowledge (Korthauer, R. D. & Koubek, R. J., 1994). The first is the use of *hyperlink approach*. Hyperlink approach is designed according to the intrinsic attributes of the information; the designer finds the best way to organize it so that the information structure is salient to the user (Gordon & Gill, 1993). This approach could commonly be seen as the underlying organization embedded in the hypermedia database, such as the hierarchical, associative, and networking structures. The second is the use of *navigational aid approach*, which is usually based on the hyperlink approach but graphically represents hyperlinks (such as the concept map) to make the information hierarchy more explicit for learners (Nelson, 1990). It is thought that instead of relying on hyperlink approach, as experienced users do, novice users may rely more upon the navigational aid approach, as they have no knowledge structure of their own (Korthauer, R. D. & Koubek, R. J., 1994). In addition to the external factor, like the hyperlink and navigational aid approaches, learners' cognitive styles are the internal factor suspected to particularly affect novice users, by affecting the degree to which they can draw out the embedded structure of the hypermedia document.

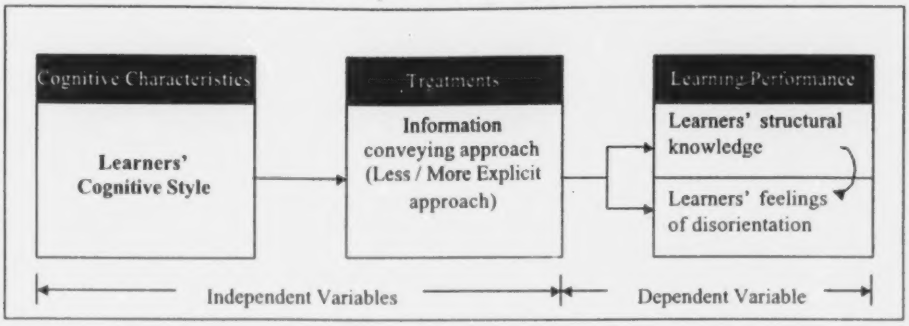
As Mandler (1983) indicated, "Meaning does not exist until some structure, or organization, is achieved" (p4). For designers and instructors, it would seem wise, then, to balance structural knowledge acquisition and the knowledge that users expect to learn in their consideration of learning results. Mental constructs could not be formed without structure. Learners might be able to remember each single object without structural knowledge, but they could not relate these isolated ideas to each other to form abstract knowledge, or even translate them into procedure knowledge (Jonassen, Beissner, & Yacci, 1993). It is important that the learner first develop an accurate structural knowledge of the knowledge domain being studied. Once the learner has a grasp of the bigger picture, he / she will be released from the burden of trying to organize the structure of the information while he / she is also required to study the content at the same time.

4 Methodology

Independent Variables

There are two independent variables in this study. First are the two types of information conveying approaches which mediate the hypermedia-based instruction. The second independent variable is the learner's cognitive style which is identified by a standard test. Figure 1 outlines a conceptual model for the variables of this study.

Figure 1. The conceptual model of variables for this study


Cognitive Characteristics
Learners' Cognitive Style
Treatments
Information conveying approach (Less / More Explicit approach)
Learning Performance
Learners' structural knowledge
Learners' feelings of disorientation
Independent Variables
Dependent Variable

Information Conveying Approach

In this study, there are two types of information conveying approaches:

1. The Less Explicit (LE) approach: the instructional material with the hierarchical-associative hyperlink

The More Explicit (ME) approach: the instructional material with an interactive concept map

Cognitive Style

The second independent variable is the learner' s cognitive style in the combination of the dimension of Wholist-Analytic and the dimension of Verbal-imagery.

1. Wholist-Verbaliser
2. Wholist-Imager
3. Analytic-Verbaliser
4. Analytic-Imager

A subject's particular style is determined by the subject's score on the Riding' s Cogntive Style Analysis (Riding, 1991).

Dependent variables

There are two types of dependent variables in this study: learners' structural knowledge and learners' feelings of disorientation.

Structural knowledge

Structural knowledge is defined here as the compilation stage of a knowledge development theory (Anderson, 1982, 1987, & 1990). It is a transition knowledge that helps learners to associate their declarative knowledge with their procedural knowledge (Jonassen, Beissner, Yacci, 1993). It represents the interrelationships between concepts that the learner forms in his or her memory.

Feeling of Disorientation

The second dependent variable in this study is a learner' s feeling of disorientation which results from his / her use of different types of information conveying approaches.

Subjects

The researcher plans to collect a total of one hundred twenty subjects participating in this study. All of the subjects will be current students enrolled in Indiana University at Bloomington (IUB). Subjects' ages range from 19 to 45, and they have various majors in the School of Education in IUB. Before this experiment, a Human Subject Form shell be completed by each subject and has been approved by the University Committee for the Protection of Human Subjects.

A two-stage filtering procedure will be administered to identify the most appropriate subjects for this study.

In the first stage of the filtering procedure, subjects will be recruited by means of an Email flyer. Experienced subjects will be excluded according to their replies on the computer background questions sent together with the E-mail flyer. The remaining respondents will receive a confirmation message from the researcher to thank them for their participation and to set up a possible time with them to come for this study. The subject filtering procedure moves to the second stage.

In the second stage of the subject filtering procedure, Riding's Cognitive Styles Analysis (Riding, 1991) will be administered to all remaining students to determine their cognitive styles: Wholist- Imager, Analytic-Imager, Wholist-Verbaliser, or Analytic-Verbaliser. This computer-based test will give measure of a subject's position on both the Wholist / Analytic and Verbal / Imagery cognitive style dimensions.

Instructional Materials

Content

The topic of this web-based instruction – "Building a Homepage", was about building a personal homepage in the IUB domain. The categories of "Building a Homepage" were adopted from the "IU Webmaster" web site (http://www.indiana.edu/~wmhome/), which is maintained by the University Information Technology Service (UITS). This web site provides information for those who wish to build or maintain a web page by themselves.

Interface layout

Two different versions of hypermedia-based instructions were developed in this study: the instruction lesson using the Less Explicit approach (hierarchical-associative hyperlink) and the lesson using the More Explicit approach (concept map). Both versions contain the same instructional content but convey it through different interface layouts. The interfaces were functionally equivalent in terms of the amount of content available in each node, and both allowed access to top-level pages at all times. Therefore, one design was not viewed by the researcher as less functional than another. These two types of hypermedia-based instructions could be accessed through using Web browsers like Netscape Navigator or Internet Explorer. Additionally, in order to control the learning environment and also to remove unpredictable factors that might affect learning, the browser's (Internet Explorer) toolbar and address bar were removed and did not appear in either approach. This was viewed as necessary in order to attempt to isolate any learning effects that may have resulted from use of the "Back" function (Boling et al., 1996).

Experiment Procedure

Upon the completion of the two-stage filtering procedure, the selected subjects will be informed of the time and the place for this experiment by E-mail. Before the study, subjects are randomly assigned into two groups – the group using the Less Explicit approach and the group using More Explicit approach. Only one group is measured at each time. In this experiment, subjects will be required to study a hypermedia-based instruction lesson. The content of this lesson is designed to help subjects acquire the knowledge to build homepages in the IUB domain. In the beginning of this experiment, subjects will be given five minutes to practice and master the tutorial web page that had been loaded on their screens. After this five minute tutorial session, subjects are required to spend at least fifty minutes (or even longer time, depending on their wishes) to read through the "Building a Homepage" web site.

When subjects complete the self-directed study, they will be required to complete a three-part post-test and a disorientation questionnaire in order to measure their structural knowledge and perceived disorientation. Subjects have a total of twenty-five minutes to finish the post-test and the questionnaire and return them together with the signed consent form to the researcher.

5 Conclusions

This study attempts to make a contribution to our understanding of how learners' cognitive attributes affect their learning performances while using hypermedia. The study results should provide some useful design concepts for hypermedia development, especially when a hypermedia material is designed for novice learners.

Learning functions play a central role in theories regarding the regulation of learning processes (Vermunt, 1989). However, the question of how students carry out these functions in a hypermedia context, or the way in which this execution is regulated by internal and external factors has largely gone unproved (Burton, Moore, & Holmes, 1995). It is worthwhile to explore whether the hyperlink or the concept map is better for different cognitive-styled learners in the acquisition of structural knowledge. As structural knowledge has been proven to be a crucial predictor of problem solving skills (Chi & Glaser, 1985; Gordon & Gill, 1989; Robertson, 1990), the information regarding whether supplied models are useful and for what kinds of users is also important for hypermedia developers.

In addition, it is hypothesized that users could overcome the disorientation problem if they could acquire a more correct structural knowledge of the knowledge domain. The findings of this study may result in insight and shed light on the importance of acquiring structural knowledge as a learning goal. Hypermedia developers may accordingly develop guidelines for designing interfaces that help users to access information and which will accommodate their needs while preserving the quality of independent learning. This should improve the effectiveness of their designs.

References

Anderson, R. C., Reynolds, R. E., Schallert, D. L. and Goetz, E. T. Frameworks for comprehending discourse. American Educational research Journal, 14(4), pp. 367-381, (1977).

Anderson, J. R. Acquisition of cognitive skill. Psychological Review, 89, pp. 369-406, (1982).

Anderson, J. R., Skill acquisition: Compilation of weak-method problem solutions. Psychological Review, 94, pp. 192-210, (1987).

Anderson, J. R., The adaptive character of thought. Hillsdale, NJ: Erlbaum, (1990).

Altun, A., Patterns in cognitive processes and strategies in hypertext reading: a case study of two experienced computer users. Journal of Educational Multimedia and Hypermedia, 8(4), pp. 423-443, (1999).

Ausubel, D. P., The psychology of meaningful verbal learning: An introduction to school learning. New York: Grune & Stratton, Inc., (1963).

Berk, E. and Devlin, J., A hypertext timeline. In E. Berk and J. Devlin (Eds.), Hypertext / Hypermedia Handbook, NY: McGraw-Hill, Inc. pp. 13-16, (1991).

Beasley, R. E., The effects of three browsing devices on learner structural knowledge, achievement, and perceived disorientation in a hierarchically organized hypermedia environment. Doctoral dissertation, University of Illinois at Urbana-Champaign, (1994).

Boling E., Kira K., Avers D., Hsu Y. C., Lee J., and Frick T., Naviagting backward: concrete vs. abstract representation in hypertext buttons. Canadian Journal of Educational Communication, 25(2), pp. 161-176, (1996).

Bruner, J. S., Toward a theory of instruction. Cambridge, MA: Belknap, (1966).

Bush, V., As we may think. The Atlantic Monthly, 176(1), pp. 101-108, (1945).

Burton, J. K., Moore, D. M., and Holmes, G. A., Hypermedia concepts and research: an overview. Computers in Human Behavior, 11(3-4), pp. 345-369, (1995).

Chang, C. T., A study of hypertext document structure and individual differences: effects on learning performance. Doctoral dissertation, University of Illinois at Urbana-Champaing, (1995).

Charney, D., Comprehending non-linear text: the role of discourse cues and reading strategies. Proceedings of Hypermedia' 87, Chapel Hill, North Carolina, November 13-15. pp. 109-120, (1987).

Chi, M. T. and Glaser, R., Problem solving ability, In R. S. Sternberg (Ed.), Human abilities: an information processing approach. NY; W. H. Freeman, (1985).

Conklin, J., Hypertext: An introduction and survey. IEEE Computer, 20(9), pp. 17-41, (1987).

Duffy, T. M., and Cunningham, D. J., Constructivism: Implications for the design and delivery of instruction. In Jonasson D. (Ed.) Handbook of Research in Educational Communication and Technology, pp. 170-198, (1997).

Elm, W. and Woods, D., Getting lost: a case study in interface design. In Proceedings of the Human Factors Society 29th Annual Meeting, pp. 927-931, (1985).

Eco, U., Semiotics and the philosophy of language. Bloomington, IN: Indiana University Press, (1984).

Gagne, R. M., Instruction & conditions of learning. In L. Siegel (Ed.), Instruction: Some contemporary viewpoints , pp. 291-313. San Francisco: Chandler Publishing Company, (1967).

Greco, A. A. and McClung, C., Interaction between attention directing and cognitive style. Educational Communication & Technology. 27(2). pp. 97-102, (1979).

Hammond, N. V. and Allinson, L., Extending hypertext for learning: an investigation of access and guidance toos. h A. Sutcliffe and L. Macaulay (Ed.), People and Computer V, Cambridge University Press, Cambridge, (1989).

Jonassen, D. H. and Grabinger, R. S., Problems and issues in designing hypertext/hypermedia for learning. In D. H. Jonassen and H. Mandl (Ed.), Designing Hypermedia for Learning. Springer Verlag. Berlin, NY. pp. 3-25, (1990).

H., Beissner, K., and Yacci, M., Structure Knowledge: Techniques for Representing, Conveying, and Acquiring Structural Knowledge. Lawrence Erlbaum Associateds, Publishers. Hillsdale, New Jersey, (1993).

Keefe, J. W., Learning Style: Theory and Practice. Reston, VA: national Association of Secondary School Principals, (1987).

Korthauer, R. D and Koubek, R. D., An empirical evaluation of knowledge, cognitive style, and structure upon the performance of a hypertext task. International Journal of Human-Computer Interaction, 6(4), pp. 373-390, (1994).

Landow, G., Hypertext: the convergence of contemporary critial theory and technology. Baltimore, MD: Johns Hopkins University Press, (1992).

Liu, M. and Reed, M. W., The relationship between the learning strategies and learning styles in a hypermedia environment. Computers in Human Behavior, 10, pp. 419-434, (1994).

McAleese, R., Navigation and browsing in hypertext. In R. McAleese (Ed.), Hypertext: theory into practice. Oxford, England, pp. 5-38, (1993).

Nielsen, J., The art of navigating through hypertext. Communications of the ACM, 33, pp. 297-310, (1990).

Paolucci, R., The effects of cognitive style and knowledge structure on performance using a hypermedia learning system. Journal of Educational Multimedia and Hypermedia, 7(2/3), pp. 123-150, (1998).

Riding, R. J. and Banner, G.E., Sex and personality differences in second language performance in secondary school pupils, British Journal of Educational Psychology, 56, pp. pp. 366-370, (1986).

Riding, R. J. and Cheema, I., Cognitive styles – an overview and integration. Educational Psychology, 72, pp. 59-64, (1991).

Riding, R. J., On the nature of cognitive style. Educational Psychology, 17(1/2), pp. 29-49, (1997).

Robertson, W. C., Detection of cognitive structure with protocol data: Predicting performance on physics transfer problems. Cognitive Science, 14, pp. 253-280, (1990).

Schwen, T. M., Goodrum, D. A., and Dorsey, L. T., On the design of an enriched learning and information environment (ELIE). Educational Technology, 33(11), pp. 5-9, (1993).

Spiro, R. J. and Jehng, J. C., Cognitive flexibility and hypermedia: Theory and technology for the nonlinear and multidimensional traversal of complex content domains. In D. Nix and R. J. Spiro (Ed.), Cognition, Education, and Multimedia: Exploring Ideas in High Education. Hillsdale, NJ: Lawrence Erlbaum Associates, (1990).

Tripp, S. D. and Roby, W., Orientation and disorientation in a hypertext lexicon. Journal of Computer-based Instruction, 17(4), pp. 120-124, (1990).

Wilson, B. G. and Jonassen, D. H., Hypertext and instructional design: some preliminary guidelines. Performance Improvement Quarterly, 2(3), pp. 34-49, (1989).

Witkin, H. A., Psychological Differentiation, Studies of Development. New York, Wiley, (1962).

Witkin, H. A., Moore, C. A., Goodenough, D. R., and Cox, P. W., Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 47(1), pp. 1-64, (1977).

Learning with Computer Mediated Communication in Remote Off-campus Cross-Cultural Contexts: Bridging the Information Gap

Lyn Henderson*, Frank York*, Gail Jose, and Anne McGowan***
**School of Education, James Cook University, Townsville, Queensland. Australia 4811*
Lynette.Henderson@jcu.edu.au, Frank.York@jcu.edu.au , Anne.McGowan@jcu.edu.au
***Education Queensland, P.O.Box 2268, Cairns, Queensland. Australia. 4870*
gail.jose@qed.qld.gov.au

The research examined the anxieties and perspectives of first and final year Australian Indigenous Bachelor of Education students as they learnt with Computer Mediated Communication. The paper reports a qualitative study that utilised Likert Scale Questionnaires and focus and individual interviews in order to ascertain the factors involved in reducing the information rich/information poor gap through the use of Computer Mediated Communication. The factors identified involved technical, time, skills, costs, tutors, and "learning style" issues as well as isolation as tertiary students studying in offcampus remote communities. The students reported more positive attitudes and competency skills and less isolation with email than the WWW. There was general optimism concerning the role the Internet would play in their future lives as students, teachers, and, as they took their knowledge beyond the classroom, in their communities, particularly in terms of reducing the information gap.

Keywords: **Computer Mediated Communication, information gap, cross-cultural, Internet**

1 Introduction

Tertiary education institutions are rapidly investing considerable resources and faith in the Internet as a means of conveying both the administrative and the pedagogical materials for student learning [1, 2]. As vehicles for flexible learning, email and the World Wide Web (WWW) are seen to be free from geographical, time, and participation restraints [3, 4]. This is juxtaposed against international concerns that the Internet is widening the gap between the information rich and information poor [5, 6]. Tertiary institutions are amongst those that continue to widen the gap between information rich and information poor in Australia as technical, cost, and inappropriately designed distributed learning environments (email and the WWW) impose implementation restraints. This paper reports a case study of how Australian Indigenous students, who are studying in remote communities, and one Australian tertiary institution, James Cook University, are bridging that information gap.

The study was interested in the tertiary students' perspectives of the influences that impacted their interpretation of that gap and how it was being bridged. We therefore investigated the students' perceptions of (a) their attitudes and anxieties concerning email and the WWW and (b) the role email and the WWW played in teaching and learning in their degree program and their lives as Indigenous peoples in remote areas.

2 Methodology

Since mid-1990, James Cook University (JCU) has offered a Bachelor of Education to Aboriginal and Torres Strait Islander students through the Remote Area Teacher Education Program (RATEP). As in the rest of Australia, Queensland' s Aborigines and Torres Strait Islanders have lived, and many continue to live, under various separatist legislation. The state government long held an isolationist and racist view of what constituted an appropriate education for them. As the official view was that they could achieve little academically, secondary education was withheld from Aborigines until 1964 and, for Torres Strait Islanders, education was left in the hands of the Department of Native Affairs, rather than the Department of Education, until 1984. RATEP was conceived as a program that would seek to redress issues of geographical remoteness, racial discrimination, economic exploitation, educational marginalisation, linguistic plurality, land alienation, and enforced dependency of the Indigenous communities. It was driven by the concepts of social justice, culturally contextualised education, empowerment, and use of information technologies. It is an inter-systemic teacher education program providing preservice teacher education studies to Indigenous students on-site in remote locations throughout the State of Queensland. The RATEP delivery partnership consists of James Cook University, the Far North Queensland Institute of Technical and Further Education, the Queensland State Education Department, and, importantly, the Indigenous communities. Multi-systemic collaboration is effected through the RATEP Management Committee which oversees finance and site selection, contributes to various corporate decisions, and provides for direct Indigenous input.

The program caters for eight to 35 Indigenous students in any year' s intake with four to 12 students at any one site. The location of the 10 James Cook University RATEP centres is usually in a primary or secondary school classroom in locations where the population ranges from 250 in Aboriginal and Torres Strait Islander communities, in which non-Indigenous people are a very small minority, to 700 in the small townships. Typically, the centre consists of one classroom which houses the computers, modem, printer, facsimile machine, teleconference phone, conference table, and study desks as well as a sink and fridge. There are no community libraries available to the students.

RATEP is a mirror of the Bachelor of Education on-campus program, differing mainly in modes of delivery. RATEP students study the same courses, are taught by the same lecturers, complete assessment tasks at the same standard as their on-campus counterparts, and receive exactly the same award as students who undertake preservice teacher education at the Cairns and Townsville JCU campuses. RATEP uses various distance education technologies, materials, and delivery strategies: textbooks, workbooks, teleconferences, audio and video tapes, facsimile, JCU developed interactive multimedia (IMM) courseware, on-site tutors (self-labelled teacher-coordinators), and, now, the Internet.

The delay in accessing the Internet as part of their program was mainly due to the costs of hardware, long distance telecommunication fees, and the unreliability of sustained telecommunication connections. With support through a Telstra learn-IT research grant, the Bachelor of Education students through RATEP were able to enrol in two undergraduate information technology courses that utilised the Internet as a teaching-learning tool. The courses were a first year core on-campus course and a fourth year elective: *Information Technologies in Education* and *Design of Educational Media*, respectively. The first year course had the equivalent of two interactive lectures on the World Wide Web (WWW). Assessment included reactions to tutorial readings sent as email attachments, and the option to create a WWW home page. Interaction with the lecturer was via email and teleconference. The fourth year course required the students to access the WWW for key readings as well as to critique educational sites. In addition, they were responsible for conducting weekly email tutorials in which two students posed email questions about the set tutorial readings. All students replied individually. The tutorial leaders were also required to synthesise these responses in a culminating email. All students were encouraged to critique any of the contributions. Except for two teleconferences, interaction with the lecturer was via email. In both subjects, the students had previously met formally and informally with their lecturers during a short orientation oncampus program.

Twenty-three out of 33 Indigenous students volunteered to participate. Their ages ranged from 21 to 49 years. Reflecting teacher education enrolments generally, all but seven were female. The students generally speak either a traditional language, Aboriginal English, or Torres Strait Creole as their first language. Standard Australian English is their second or third language. When researching in cross-cultural contexts it is important that researchers acknowledge the cultural, linguistic, and individual differences existing within and across the student group. However, the historical-socio-cultural similarities are strong enough to speak in generalities in referring to Aboriginal and Torres Strait Islander patterns of experiences, values, and ways of learning.

Audiotaped focus interviews were conducted either face-to-face (Yarrabah) or via teleconference (Normanton and Woorabinda) with students as a group at these three RATEP sites. The interviews involved open-ended questions to gather information about the issues identified by the students and teacher coordinators as relevant to learning with the Internet. A five-point Likert Scale Issues and Course Questionnaire for the first and final year courses were compiled from the focus interview data and the literature. It was administered towards the end of the courses, either along with audiotaped individual interviews conducted on site with students at six RATEP sites (Thursday Island, Bamaga, Napranum, Cairns, Palm Island, and Cunnamulla) or via fax or email attachment to the other four sites (Yarrabah, Normanton, Worrabinda, and Doomadgee). Another five-point Likert Scale questionnaire assessing Computer Mediated Communication Anxiety [7] was also administered at the beginning and end of the two university courses involving the Internet via fax or email.

3 Data Results and Discussion

The five point Likert scale questionnaires were reduced to a three point scale (see Table 1) for data analysis. Overall there was a positive swing on the Computer Mediated Communication Questionnaire (Items 1-13, Table 1) and the Issues and Course Questionnaire (Items 14-23, Table 1) that sought first and final year student anxieties and perceptions about current and future usage of email and the World Wide Web (WWW). (Ten items out of the 42 item Issues and Course Questionnaire are reported here; the other items included those that are common in end-of-course evaluations and, therefore, not relevant to this paper). The individual interviews supported this trend. The interviews revealed a decidedly positive emphasis on keeping but improving the use of CMC in RATEP subjects.

Table 1: Comparison of Pre to Post Test Changes on Selected Items from Computer Mediated Communications and Comparison between End-of-Semester First Year and Final Year Issues and Course Evaluation Questionnaires

Computer Mediated Communications Questionnaire: Responses of Students' Studying First and Final Year Course							
Item		Pre-Test			Post-Test		
		SA-A	U	D-SD	SA-A	U	D-SD
1	E-mail could open up new communication channels for me.	92%	8%		94%	4%	
2	My usage of e-mail will increase in the future.	67%	33%		91%	9%	
3	The thought of using e-mail makes me nervous.	50%		50%	30%	9%	61%
4	The Internet could open up new areas of communication for me	100%			100%		
5	I expect I will use the Internet in the future	83%	8%	8%	96%	4%	
6	I get nervous at the thought of using the Internet	50%		50%	39%	13%	48%
7	I believe that there are many useful ways to use the Internet.	67%	17%	17%	68%	17%	14%
8	The thought of learning from the Internet intimidates me.	36%	27%	36%	30%	17%	52%
9	Information overload frightens me.	50%	8%	42%	43%	30%	26%
10	I feel very negative about the Internet in general.	33%	17%	50%	26%	30%	43%
11	I would prefer not to use the Internet because of the uncensored material	25%	8%	67%	30%	22%	48%
12	Using the Internet could be more trouble than its worth	25%	33%	42%	17%	17%	65%
13	I think there is too much emphasis placed on	67%	17%	17%	35%	26%	39%

	the Internet						

First and Final Year Issues and Course Evaluation Questionnaire Responses

Item		First Year Course			Final Year Course		
		SA-A	U	D-SD	SA-A	U	D-SD
14	I am more confident using email than the WWW	73%	9%	18%	67%	11%	22%
15	If I had the choice, I would use the WWW for serious information searches	100%			100%		
16	If I had the choice, I would use the WWW to catch up on what' s happening in soap operas.	27%	9%	63%	33%	22%	44%
17	The WWW is a diversion from having to do RATEP work.	20%	20%	60%	22%	33%	44%
18	I don' t feel as isolated as a university student now that I can use WWW	54%	36%	9%	56%		44%
19	I don' t feel as isolated as a university student now that I can use e-mail	82%		18%	100%		
20	I appreciated the flexibility in scheduling my learning times	73%	18%	9%	89%	11%	
21	The subject has made me feel a more independent learner	50%	30%	20%	78%	22%	
22	I no longer see the computer as just a word processing tool	100%			80%	20%	
23	I intend using the computer in the classroom with my students.	100%			100%		

* SA-A = Strongly Agree/Agree; U - Undecided; D-SD = Disagree/Strongly Disagree.

Students were originally divided on their willingness and nervousness to use email. By the end of the semester there was a substantial increase in their perception that their future usage of email would increase (67% to 91%) and a 20% decrease in their nervousness (Items 2 & 3, Table 1). This is encapsulated in one student' s interview statement: "I was a bit apprehensive at first because I think the newness with everybody was a bit scary. But, after I got the knack of things, I really loved it" (Interview). Most students acknowledged the efficiency and speed of communicating via email with their lecturers and fellow students; as one student explained: "...you don't have to fiddle around faxing or posting your assignments. You just type it right onto the computer and send it on the email and it's there!" (Interview). Some reasons for the maintenance of apprehension involved concerns about costs ("the time I' m using is costing money"), typing skills ("my typing speed is not up to my thoughts; that' s a bit slower so that' s what holds me back"), and privacy ("..the teacher-coordinator seemed as if to be spying" (Interviews). This last factor involved the way email accounts were established. Because of costs, only one modem was provided at each site. Thus, at the time of the research, the teacher coordinator accessed and therefore could read all exchanges as the single email account for each RATEP site was registered in their name. (This year, all students have a private email account.) Despite their concerns and apprehensions, 94% agreed that email would open up new communication channels for them while 91% indicated they would increase their use of email in the future (Items 1 & 2 respectively, Table 1).

Compared with email items, there was more initial negativity and some smaller positive swings concerning the WWW items. Indeed, at the end of the semester, both first and final year students admitted they were "more confident using email than the WWW" (73% and 67%, respectively; Item 14, Table 1). In the pre and post Computer Mediated Communication Questionnaire, for instance, although in the post test 68% agreed with the item, "I believe that there are many useful ways to use the Internet", there was little variation from the pre test (67%) (Item 7, Table 1). Other small positive results occurred in the following items as fewer students indicated agreement with the following statements: "I get nervous with the thought of using the Internet (50% pre test to 48% post test); "The thought of learning with the Internet intimidates me" (36% to 30%); and "Information overload frightens me" (50% to 43%) (Table 1, Items 6, 8, & 9, respectively).

However, it is noteworthy that on three of these items such positive swings were offset by a noticeable increase in the "undecided" category. For instance, in the above item about nervousness and using the Internet, 50% agreed and 50% disagreed on the pre-test while 39% agreed and 48% disagreed on the post-test (Item 6, Table 1). The change in attitude was counteracted by an increase in the "undecided" (0% to 13%; Item 6, Table l). Although more students felt less negativity about information overload (Item 9) and the WWW in general (Item 10), 30% reported being "undecided" in the post test compared with 8% and 17% in the pre test, respectively (Items 9 & 10, Table 1). As explained later, many of the first year students were prevented from hands-on use of the WWW course materials online. In the fourth year subject, the greater emphasis was on email tutorial interaction; in comparison, finding relevant resources and obtaining set readings from the WWW were the only compulsory WWW tasks. This paucity of "compulsory" usage, influenced the students perceptions concerning the Internet. During the interviews, most students equated the Internet with the WWW. The experiences that the students did have seemed to have resulted in understandable ambiguity concerning their anxiety and general attitudes about the WWW; the reality of their experiences was a contributing factor.

More substantial changes occurred when, in the post test, fewer students agreed with the statement, "I think there is too much emphasis placed on the Internet" (67% to 35%) (Item 13, Table 1) and more students confirmed that they would use the Internet in the future (83% to 96%) (Item 5, Table 1). As one student commented: "You have to keep up with the technology and pass it on; it's never-ending learning" (Interview). Additionally, regardless of their concerns and experiences, an optimism remained: all confirmed an unchanged hope that the Internet would open up new areas of communication for them (100% on both pre and post tests, Item 4, Table 1).

There were several factors affecting these data results, such as technical issues, time, skills, costs, and tutors (self-labelled "teacher-coordinators").

Technical problems were a significant factor. Getting hooked-up took two sites one month after the commencement of the courses. The reliability of the telecommunication links and difficulty in logging into the James Cook University site when 500 on-campus students were trying to log into the same first year course site influenced the RATEP students' perceptions (Interviews). The one computer that had the RATEP modem connection was also used for studying with the IMM courseware and wordprocessing assignments. An extra major inconvenience for two sites was having just one line for Internet access, facsimile, telephone, and teleconferencing. There was a ratio of approximately four students to this one line.

These factors obviously limited the time each student could spend using the WWW and email. Their other study commitments - described as "a mountain of work" by one student - imposed further time constraints reducing their usage of the Internet (Interviews). This was exacerbated by having English-as-a-second/third-language with respect to deconstructing academic genres. "If we'd had more time to explore it and build up that confidence, well, then, I probably wouldn't be feeling as bad as I do about getting onto it," was one student's summary of the effects that lack of time had on her self-confidence (Interview). Others echoed the impact that minimum usage had on their confidence to use the WWW (Interviews). The printout of procedures on the wall did not seem to inspire usage or confidence; it was the personal input from the teacher-coordinator or a peer that some students' maintained was crucial. This emphasis on the personal coach would seem to reflect Aboriginal and Torres Strait Islander preferred ways of learning and doing [8]. In this period of apprehension with using the Internet, students required the comfort zone of traditional ways of teaching and learning [9].

Underdeveloped procedural knowledge constrained student progress using the WWW. One student's clarification echoed other students' comments: "..it's just a matter of not being able to get where I want to be straight away ...and then I'll get real frustrated" (Interview). Students justifiably argued that this was compounded by the fact that the first year course did not encourage understanding or reinforcement of WWW searching strategies by requiring assessable activities in this area.

There was evidence of self-imposed moderation in usage by students (Interviews). In spite of their understanding that costs involved in browsing the WWW were met through the Telstra learn-IT grant, students were reluctant to abuse what they saw as a privilege.

The students who reported most positively in their interviews were those who perceived their teacher-coordinators as having competence in using the WWW and being able and willing to impart that confidence to the students. Unfortunately a few students cited perceptions of teacher-coordinator reluctance or inability to share their knowledge. Also most of the teacher-coordinators printed out the first year course's WWW lecture notes. The teacher-coordinators contended they chose this strategy because of time constraints, technical hiccups, and, perhaps, admitted one, procedural insecurities. For them, this allowed a more efficient usage of time as they could conduct tutorials based on the printed text without having to wait for all the students to study from the WWW. In effect, it prevented students acquiring more proficiency with the Internet and, hence, much needed self-confidence. As well it prevented students (and these teacher coordinators) from obtaining a better understanding of how the WWW could be utilized as a learning tool as they had no chance to participate with the in-built question-answer-feedback interactions, the video clips of school children voicing their perceptions of various aspects of the Internet and its relevance to their lives, and the hypertext/hypermedia functions of the WWW.

These conditions would have influenced the differing perceptions about the courses allowing "me to feel a more independent learner" (Item 21, Table 1): only 50% of the first year students felt such independence with a further 30% being undecided; in comparison, 78% of the final year students reported that the Internet activities had helped them to take more self-responsibility for their learning. Of course, one would expect that final year students would be more independent learners than first year students. Nevertheless, the item required them to express an opinion if the Internet subject had made them "more" independent.

Even if many had not had much opportunity to browse the Web, all students reiterated the commonly quoted advantages of the WWW: up-to-date information, variety of topics, exploration, multiple sources relating to the same information, and flexibility (Interviews). With respect to flexibility, more final year students (89%) compared with first year students (73%) valued this attribute (Item 20, Table 1). The enforced tutorials without personal access to the WWW would have influenced the first year students' perceptions. One student situated her comment in the context of the realities of Indigenous community life: "We've had multiple tragedies in our class [deaths, suicides, and serious illnesses]; at least with the WWW lecture notes, we can come back and get them; we're not missing out [as we would have with teleconferences]" (Interview). For students who had taken opportunities to surf, the WWW was "Exciting!"; "It gets me; it draws me. I could see myself seriously getting hooked"; "It's like a big book; you don't want to put it down!" (Interviews).

Students unanimously agreed that they would use the WWW for serious information searches (Item 15, Table 1). It was reassuring to see that their usage went beyond the two courses requiring utilisation of the Internet. The following Web searches were mentioned by different individual students: green ants (for their science curriculum course); background information on a son's medical disease; solutions for our farm's fruit tree problems; Indigenous sites such as the internationally famous Aboriginal band, Yothu Yindi. Serious play [10, 11] was involved, too: finding out what was on at movie theatres; joining a jokes' listserv; 30% admitted to catching up on soap operas (averaged first and final year, Item 16 Table 1); and 21% reported using the WWW as an occasional diversion from their studies (averaged first and final year, Item 17 Table 1). Such responses demonstrate these students' awareness of the types of information available on the WWW and an ability to conduct searches and find out how to subscribe to a listserv. Because of the Internet and other computer requirements in the two courses, 90% (averaged first and final year students, Item 22, Table 1) agreed that they no longer perceived the computer as just a word processing tool.

The role of email and the WWW in their lives as students in remote Indigenous communities involved reducing isolation and person, societal and professional issues.

Feeling part of the wider JCU student cohort was an issue raised in the research. Both cohorts of students felt that isolation as a university student was decreased through use of email - 82% for first year students and 100% for final year students (Item 19, Table 1). One student put it succinctly: "Yeah. It took away the isolation a lot" (Interview). In comparison, approximately half (54%) of the students studying the first year course reported that they "did not feel as isolated as a university student now that I can use the WWW" (Item 18, Table 1). A further 36% were undecided. Likewise, only 56% of the final year students felt that isolation as a university student was reduced through access to the WWW (Item 18, Table 1). The course requirements and amount of access would have been significant issues in the differing percentages with respect to email and WWW as factors in lessening isolation. With respect to the first year students, these percentages are not surprising considering the large number of reports of inadequate access to the WWW, working from a print version rather than on-screen interaction of the first year information technology course, and technical constraints. The fourth year course demanded that the students conduct weekly email tutorials and interact via email for a fortnight with students at the Royal Melbourne Institute of Technology as well as the fact that their compulsory WWW activities were limited. The results may also have been affected by the fact that the WWW activities were not people orientated whereas the email tasks were obviously so.

However, isolation was not just a matter of the difficulties imposed by distance learning with respect to cultural induction as university students. It was also a personal and community issue. A few students reported keeping in touch via email with relatives and friends living in other parts of Australia; for instance, one student was able to regularly contact her son who was in jail. This is a poignant reminder of the systemic injustices involved in Aboriginal and Torres Strait Islander peoples' reality and the role that email can play in helping families maintain contact at a geographical distance. The WWW was threatening for one student: " ... a whole new world, and I'm afraid in a way to experience all these different things" (Interview). For others, their world was expanded. This was insightfully expressed by one student: "When you're living in a remote community all you know is what's happening around here or what you get from your teleconference and stuff like that. You're living in your own world ...Well, then, when you get onto the Web, it's just like: 'Wow! There's a big world out there. All that information you can access'." (Interview).

The content in the first year course *(Information Technologies in Education)* appeared to have been influential in changing perceptions about the negative affects of the Internet. One involved society's concern that the Internet would significantly reduce or even prevent socialisation. For example, "I've changed", said one student. "I've done a complete [voice faded out] ...with the whole idea of technology taking away the emotional side of life and that we've been becoming too dependent on it, and I think, after going through the semester with it, that maybe as long as people are educated in the right way about it, it's not going to prove to be a big problem. It's probably going to prove to be a big asset, you know." Some students' comments highlighted their fear of children and themselves encountering pornographic sites: "It scares me - to come across something like that on the Internet"; "Children shouldn't have access to them" (Interviews). However, the 19% pre to post drop in their disagreement with the statement, "I would prefer not to use the Internet because of the uncensored material" (Item 11, Table 1), probably reflects a more realistic understanding of avoidance strategies and the general unlikelihood of a user encountering such sites; these were issues that were discussed with relevant hotlinks in the WWW course.

All the pre-service teachers reported their intention to use computers in the classroom with their students in order to enhance teaching and learning (Item 23, Table 1). One student commented that hers was a commitment to creating a new kind of learning environment for all, but particularly remote Indigenous, students. Another student saw that this would occur during her next practicum: " ...I think that I can go to the Web and find out interesting lessons, which is one of my main concerns. Kids sit down and get stuff poured into them that is not interesting." The students' commitment demonstrates a broader consideration of the role that the WWW and email needs to play in school and, as the students' take their understandings home, their communities.

4 Conclusion

Overall, at the end of phase one of the project, there was a favourable response to the introduction of the Internet into the students' Bachelor of Education course. Importantly, the research highlighted a number of issues that the RATEP Academic Coordinator, lecturers, and RATEP Management Committee can consider to help improve the incorporation of the Web and email for improved teaching and learning: technical issues such as the provision of more than one modem per RATEP site; incorporation of assessable items to do with effective searches on the WWW; meaningful use of email and Web discussion forums in various subjects across the degree program; seeing serious play that helps develop WWW procedural skills as part of the course structure; examination of the nature and role of WWW lectures in developing conceptual as well as procedural understanding of the WWW; and creating purposeful "authentic" links between the Internet subjects and their community.

It is argued that the Internet will prove to be an effective tool to combat colonisation. For instance, geographically dispersed Aboriginal communities and Torres Strait Islander communities are able through the Internet to set their own agendas to communicate and consult (network) on issues of mutual concern, such as the current attention concerning land and sea rights claims. In the second phase of the learn-IT research grant, we conducted an Internet WebBoard International Conference linking Indigenous and non-Indigenous peoples interested in teaching and learning with the Internet. Once analysed, the rich data from this conference should provide further ideas for bridging the information gap, not only to empower, but to provide ownership of the Internet in school, tertiary, and community life.

5 References

[1] Paulsen, M. F., "Computer mediated communications and distance education around the world", Vol. 7, pp. 31-37, 1992

[2] Rudra, A. (1994). AARNet and ERNET: An era for fostering international academic research. In N. F. Ellerton (Ed.), Proceedings of International networking: Education, training and change (pp. 104-109). Perth, Western Australia: Edith Cowan University.

[3] Nguyen, A. T. A., Tan, W., & Kezunovic, L. (1996). Interactive multimedia on the World Wide Web: Implementation and implications for the tertiary education sector. In M. Nott (Ed.), Proceedings of AusWeb96: The Second Australian World Wide Web Conference. Gold Coast, Australia: Southern Cross University.

[4] Rossman, P. (1992). *The emerging worldwide electronic university: Information age global higher education*. Westport: Greenwood Press.

[5] Provenzo, E. (1986). Beyond the Gutenberg Galaxy. New York: Teachers College, Columbia University.

[6] Rowe, H. (1993). Learning with personal computers. Hawthorn, Vic.: Australian Council for Educational Research.

[7] King, J., Henderson, L., & Putt, I. (1997). Measuring affective aspects of www and e-mail use in course delivery. In Muldner, T., & Reeves, T. (Eds.), Educational multimedia/hypermedia and telecommunications, 1997, (Vol. 1), (pp. 595-600). Charlottesville: Association for the Advancement of Computing in Education.

[8] Osborne, A.B., (1982). Field Dependence/Independence of Torres Strait Islander and Aboriginal Pupils. Journal of Intercultural Studies, (3)3, 5-18.

[9] Henderson, L. "Instructional design of interactive multimedia: A cultural critique". Educational Technology Research & Development, Vol. 44, No. 4, pp. 85-104, 1996.

[10] Provost, J. (1990). Work, play and type: Achieving balance in your life. Palo Alto, CA: Consulting Psychologist Press.

[11] Rieber, L. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. Educational Technology Research & Development, 44(2), 43-58.

Making Exploration History Interactive for Web-based Learning

Akihiro Kashihara, Masanao Sakamoto, Shinobu Hasegawa, and Jun'ichi Toyoda

The Institute of Scientific and Industrial Research, Osaka Univ., JAPAN
8-1, Mihogaoka, Ibaraki, Osaka 567-0047, JAPAN
kasihara@ai.sanken.osaka-u.ac.jp

The main problem addressed in this paper is how to help learners reflect on knowledge that they have constructed in exploring existing hypermedia/hypertext based learning resources on the Web. Our approach to this problem is to provide each learner with a kind of reflection support proper to his/her exploration process. In this paper, we describe an interactive history that encourages learners to annotate their exploration history with the reasons why they have explored, which reasons have a great influence on knowledge construction in hyperspace. It also generates a knowledge map, which spatially represents the semantic relationships among the WWW pages visited by the learners. This paper also describes a preliminary analysis and evaluation with the interactive history system. The results indicate that the system facilitates a rethink on exploration processes, and that the system produces good effects on learning such as integrating the contents of some nodes in more complicated hyperspace.

Keywords: Exploratory Learning, Hyperspace, Reflection, Interactive History

1 Introduction

Hypermedia/hypertexts generally provide learners with a hyperspace within which they can explore the domain concepts/knowledge in a self-directed way [3], [7]. The exploration often involves making cognitive efforts at constructing the knowledge from the contents that have been explored [12]. These cognitive efforts would enhance learning [2], [6]. However, learners often fail in knowledge construction since what and why they have explored so far become hazy as the exploration progresses. To what extent the learning has been carried out also becomes unclear [10], [12].

A possible resolution of this problem is to encourage learners to reflect on what they have constructed during exploration in hyperspace [11], [12]. The reflection also involves rethinking the exploration process that they have carried out since it has a great influence on their knowledge construction. In particular, exploration purposes, which mean the reasons why the learners have searched for the next node in hyperspace, play a crucial role in knowledge construction [8], [9]. For instance, a learner may search for the meaning of an unknown term to supplement what is learned at the current node or look for elaboration of the description given at the current node. Each exploration purpose would provide its own way to shape the knowledge structure. The reflection support accordingly needs to adapt to their exploration activities and the knowledge structure being constructed by the learners.

In this paper, we discuss a proper reflection support with a careful consideration of exploration process in hyperspace. This paper also describes an interactive history for learning with hypermedia/hypertext based learning resources on the Web. The interactive history system enables learners to annotate their exploration history with exploration purposes that have arisen during exploration. It also transforms the annotated exploration history into a visual representation called knowledge map. It spatially shows the semantic relationships among the WWW pages that the learners have visited [8]. Using the interactive history system, the learners can view and reorganize the exploration history to rethink their exploration process that they have carried out so far. They can also view the knowledge map to reflect on what they have constructed in hyperspace.

This paper also describes a preliminary evaluation of utility and effectiveness of the interactive history system. The results indicate that the system facilitates a rethink on exploration processes, and that the system facilitates learning such as integrating the contents of some pages in more complicated hyperspace.

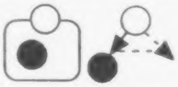
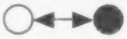
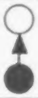
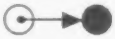
Before discussing the interactive history, let us first consider exploration process in hyperspace.

2 Exploratory Learning

In hyperspace, learners can explore in a self-directed way from one node to others by following the links among the nodes. The exploration often involves making cognitive efforts at constructing the knowledge structure from the contents that have been explored. In order to shape a well-balanced knowledge structure, it is necessary for the learners to recall what and why they have explored so far, and to properly direct the subsequent exploration [10], [12], [13]. However, these efforts may cause cognitive overload [6].

In this paper, we consider learners who attempt to learn domain concepts and knowledge in a constructive way. Some learners may not make the cognitive efforts of knowledge construction. In this case, they may only browse or surf in hyperspace. Supporting such browsing or surfing is out of our scope.

Table 1. Exploration Purposes and Visual Representation.

Exploration Purposes	Visual Representation	
Supplement	Inclusion	
Elaborate	Set or Part-of tree	
Compare	Bidirection arrow	
Justify	Vertical arrow	
Rethink	Node superposition	
Apply	Arrow	

○ Starting node ● Terminal node

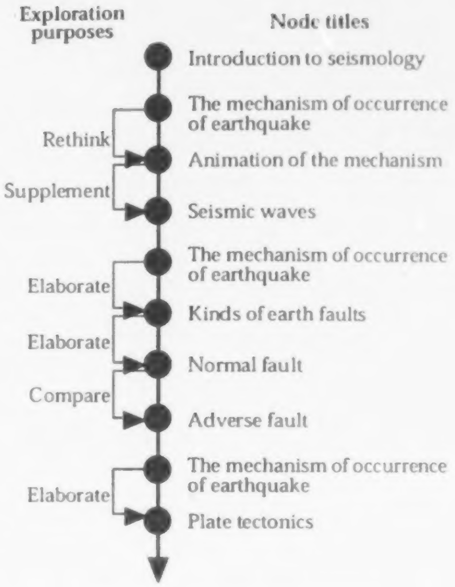

Exploration purposes
Node titles
Introduction to seismology
The mechanism of occurrence of earthquake
Rethink
Animation of the mechanism
Supplement
Seismic waves
The mechanism of occurrence of earthquake
Elaborate
Kinds of earth faults
Elaborate
Normal fault
Compare
Adverse fault
The mechanism of occurrence of earthquake
Elaborate
Plate tectonics

Figure 1. An Exploration History.

2.1 Primary Exploration Process

Learners generally start exploring hyperspace with a learning purpose. The movement between the various nodes is often driven by a local purpose called exploration purpose to search for the node that fulfills it. Such exploration purpose is also regarded as a sub purpose of the learning purpose. We refer to the process of fulfilling an exploration purpose as primary exploration process. This is represented as a link from the starting node where the exploration purpose arises to the terminal node where it is fulfilled.

An exploration purpose may have several terminal nodes with one starting node. Exploration purpose, represented as verb, signifies how to develop or improve the domain concepts and knowledge learned at the starting node. We currently classify exploration purposes as shown in Table 1, which are not investigated exhaustively.

An exploration purpose arising from visiting a node is not always fulfilled in the immediately following node. In such case, learners need to retain the purpose until they find the appropriate terminal node/s. While searching for the fulfillment of the retained purpose, it is possible for other exploration purposes to arise. The need to retain several exploration purposes concurrently makes the knowledge construction more difficult to achieve.

The exploration process can be modeled as a number of primary exploration processes. Let us give an example where a learner uses a hyperdocument on a WWW server with the learning purpose of understanding the occurrence of earthquake. In this example, he/she explores a number of nodes (WWW documents) with various exploration purposes. Figure 1 gives the exploration history, which shows the sequence of the nodes visited and primary exploration processes. For example, he/she visited the node *Animation of the mechanism* in order to rethink the description in the node *The mechanism of occurrence of earthquake*. He/she then visited the node *Seismic wave* since he/she did not know the meaning of the term used in the previous node.

2.2 Knowledge Structure

Exploring hyperspace in a self-directed way, learners make semantic relationships among the domain concepts and knowledge explored to construct a knowledge structure [12]. In hypermedia/hypertext systems with concept maps representing domain concepts to be learned, learners can derive such semantic relationships from the maps. Most existing web-based learning resources, on the other hand, do not specify the semantic relationships. In this case, learners need to explore WWW pages and to identify the semantic relationships by themselves for the knowledge construction.

The knowledge structure constructed is shaped according to learners' exploration process, especially the exploration purposes. Each exploration purpose provides its own way to make relationships among the domain concepts and knowledge explored and to shape the knowledge structure [8].

2.3 Reflection

Knowledge construction in hyperspace requires learners to reflect on their exploration process. Some work on analysis of exploration process in hyperspace has also shown that revisiting nodes to rethink the contents explored often take place [11], [13].

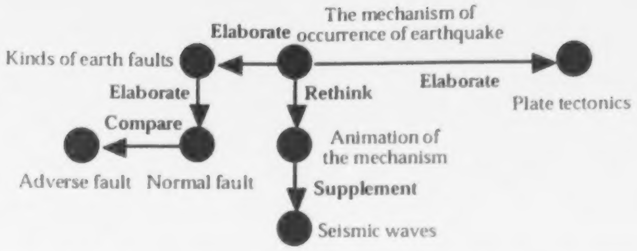


Figure 2. A Semantic Network Composing Primary Exploration Processes.

In reflection, it is important for learners to rethink not only the nodes visited but also the reasons why they have visited since these reasons have a great influence on how to shape a knowledge structure. In other words, they should pay attention to primary exploration processes included in the whole exploration process.

3 Interactive History

Let us now discuss what kind of reflection support is indicated by the above consideration.

3.1 Problems

There are the following important problems to be addressed towards a proper reflection support. The first problem is how to help learners retain the primary exploration processes that they have carried out. The retention may cause cognitive overload on exploration. It is also hard for computer to infer their exploration purposes, which arise in the learners' mind. These suggest that learners should be encouraged to note down the exploration purposes, starting nodes, and terminal nodes that compose the primary exploration processes.

The second problem is how to assist learners in reconstructing their exploration process. In reflecting on their exploration process, they would not only look at it but also reconstruct it such as modifying/deleting the primary exploration processes and adding new primary exploration processes. It is accordingly necessary to provide learners with a space where they can reconstruct their exploration process after exploring hyperspace.

The third problem is how to facilitate learners' reflection on a knowledge structure constructed. One way to resolve this is to spatially show semantic relationships between nodes explored. We represent a semantic network that comprises a number of primary exploration processes. Figure 2 shows a semantic network comprising the primary exploration processes shown in Figure 1. The semantic network does not obviously represent the contents included in the explored nodes, which may be summarized by the node titles. However, this summarized information would be substantially fruitful for learners to reflect on what they have learned.

In order to resolve the above problems, we have developed an interactive history that helps learners reflect on their exploration process and knowledge structure by means of an exploration history annotated with primary exploration processes. Let us next demonstrate the interactive history.

3.2 Overview

The interactive history system first displays an exploration history, which includes the nodes sequenced in order of time learners visited. In order to help learners note down primary exploration processes during exploration, the system provides them with a list of exploration purposes, and requires them to select one from the list when an exploration purpose arises. The learners are also asked when they find the terminal nodes. The interactive history system annotates the exploration history with the information noted down. The annotated history enables the learners to retain their primary exploration processes.

The learners are also allowed to directly manipulate the annotated exploration history to modify/delete the primary exploration processes and to add new primary exploration processes after exploring hyperspace. Such direct manipulation allows them to reconstruct their exploration process without revisiting hyperspace.

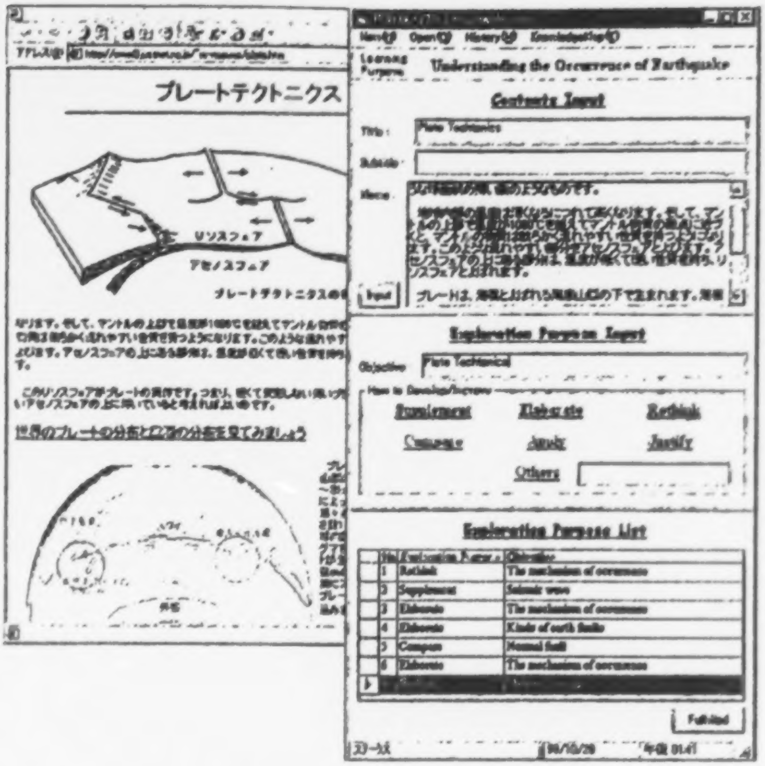
Although the annotated exploration history is represented as semantic network shown in Figure 2, it may be difficult to understand. It is accordingly transformed into a visual representation called knowledge map by means of visualization scheme that describes the correspondence of an exploration purpose to a visual representation.

3.3 Annotated Exploration History

In the interactive history system, learners can use a user interface as shown in Figure 3. They can also explore a hyperdocument on a WWW server with one learning purpose in the left window. When they want to set up an exploration purpose in visiting a node, they are required to click one corresponding to the purpose in the *Exploration Purpose Input* section of the right window. The clicked purpose is added to the *Exploration Purpose List* section. The node visited currently is also recorded as the starting node of the exploration purpose.

The learners can also add the object of the verb describing the exploration purpose. It means what to develop/

BEST COPY AVAILABLE



Title: Plate Techtonics

Objective: Plate Techtonics

No.	Exploration Purpose	Objective
1	Rethink	The mechanism of occurrence
2	Supplement	Seismic wave
3	Elaborate	The mechanism of occurrence
4	Elaborate	Kinds of earth faults
5	Compare	Normal fault
6	Elaborate	The mechanism of occurrence

Figure 3. User Interface of Interactive History.

improve in the current node whereas the exploration purpose specifies how to develop/improve. When the learners do not add this object, the system adds the title of the current node, which is the title tag in the HTML file.

When the learners find a terminal node of the exploration purpose, they are required to mouse-select the exploration purpose in the *Exploration Purpose List* section, and to push the *fulfilled* button. The node visited currently is then recorded as the terminal node of the exploration purpose.

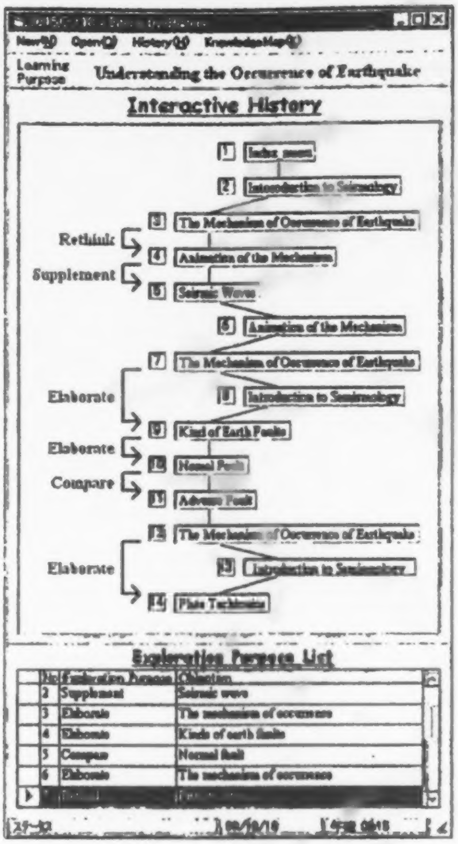
The system also provides another support for helping learners store part of the contents of the node visited currently with Cut&Paste function in the *Content Input* section although they may not always need this support. In hyperdocuments on WWW, in addition, the title tags of the nodes do not always represent the contents of the nodes. If the learners want to change the node titles, they can input new titles in the *Content Input* section, which new titles should represent the contents the learners explored in the nodes. The pasted information and the changed node titles are also used in the annotated exploration history.

Using the information inputted from the learners, the system generates the annotated exploration history as shown in Figure 4 so that the primary exploration processes can be viewed clearly. In the annotated history, the nodes learners visited are sequenced in order of time. Each node has the node title. The starting node of each purpose is linked with the corresponding terminal node/s. There may be some primary exploration processes without terminal nodes since they have not been found yet. The learners can look at the annotated exploration history on their demand during exploration. They can also click the nodes in the history to review the content information, which they have inputted with Cut&Paste function.

Learners are not always required to input the above information whenever they visit nodes. Nevertheless, inputting the information during exploration may be troublesome for learners. On the other hand, it enables the learners to make their exploration more constructive, facilitating their exploratory learning. This point is discussed later in detail.

3.4 History Manipulation

Directly manipulating the annotated exploration history, the learners can reconstruct their exploration process without revisiting hyperspace. Each manipulation is done by means of mouse-clicking/dragging parts of the primary exploration processes. There are three basic manipulations: deleting and changing exploration purposes/links between starting and terminal nodes, and adding new primary exploration process.


New(N) Open(O) History(H) KnowledgeMap(K)
Learning Purpose
Understanding the Occurrence of Earthquake
Interactive History
1 Index room
2 Introduction to Seismology
3 The Mechanism of Occurrence of Earthquake
Rethink
4 Animation of the Mechanism
Supplement
5 Seismic Waves
6 Animation of the Mechanism
7 The Mechanism of Occurrence of Earthquake
Elaborate
8 Introduction to Seismology
9 Kind of Earth Faults
Elaborate
10 Normal Fault
Compare
11 Adverse Fault
12 The Mechanism of Occurrence of Earthquake
Elaborate
13 Introduction to Seismology
14 Plate Techtonics
Exploration Purpose List
98/10/16

No	Exploration Purpose	Objection
2	Supplement	Seismic wave
3	Elaborate	The mechanism of occurrence
4	Elaborate	Kinds of earth faults
5	Compare	Normal fault
6	Elaborate	The mechanism of occurrence
7	[illegible]	[illegible]

Figure 4. An Annotated Exploration History.

3.5 Knowledge Map Generation

In order to make the knowledge map understandable, we have adopted a visualization scheme shown in Table 1. This table shows the correspondence of an exploration purpose to a visual representation of the relationship between the starting and terminal nodes. For example, an exploration purpose to *Elaborate* is transformed into a set that visualizes the starting node as a total set and the terminal node as the subset. An exploration purpose to *Rethink* is also transformed into a visual representation that superposes the starting node on the terminal node. Following such correspondence, the system generates a knowledge map by extracting the primary exploration processes from the annotated exploration history. The knowledge map generation is executed on learners' demand before/after manipulating the annotated exploration history.

Figure 5 shows an example of the knowledge map that is generated from the annotated exploration history shown in Figure 4. Viewing this map, the learner can reflect on his/her knowledge construction. For example, he/she can recall that he/she rethought *The mechanism of earthquake occurrence* by exploring *The animation of the mechanism*. He/she can also recall that he/she compared *Normal fault* and *Adverse fault* to elaborate the description about *Kind of earth faults*.

3.6 Discussion

Let us now discuss several points to notice in utilizing the interactive history. The interactive history system requires learners to input information about primary exploration processes that have been carried out. Such inputting, in addition, requires a meta-cognitive skill that is indispensable for managing knowledge construction process in existing web-based learning resources. The interactive history system could distract learners, who do not have it, from their learning tasks in hyperspace. We believe, however, it is educationally important to train the learners to improve the meta-cognitive skill so that they can learn in the Web. The interactive history can be viewed as a potential tool for this training.

Before using the interactive history system, in addition, learners need to know how to interpret the visual repre-

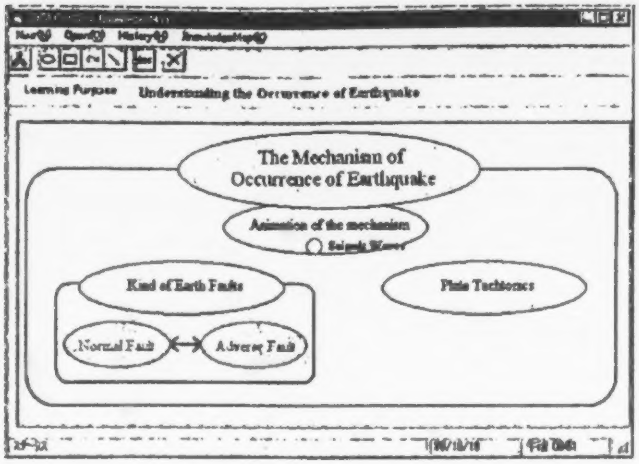

Learning Purpose
Understanding the Occurrence of Earthquake
The Mechanism of Occurrence of Earthquake
Animation of the mechanism
Seismic Waves
Kind of Earth Faults
Plate Techtonics
Normal Fault
Adverse Fault

Figure 5. A Knowledge Map.

sentation used for the knowledge mapping. In order to explain it, the interactive history system demonstrates few examples of annotated exploration history and knowledge map before starting the actual learning support.

Let us next compare with related work on reflection support to consider the usefulness of the interactive history. The general browsers such as Netscape and Internet Explorer enable learners to revisit nodes with back buttons, and provide browsing history. However, these facilities do not always make the retention of their exploration processes easy [11]. As the retention support, there are several kinds of annotation systems that allow learners to take a note [1]. However, there is little discussion of what kind of annotation should be done for the success in exploratory and constructive learning. In the interactive history, we claim that the reasons why learners search for the next nodes should be particularly noted down.

Current work on adaptive hypermedia/hypertext systems has often provided spatial maps and concept maps as reflection support, which are originally used as navigational aid. Spatial maps display the nodes and links that compose the whole structure of hyperspace. These maps can visually represent the subspace where learners have already visited [4]. This subspace is represented as the partial structure of hyperspace. This visual representation can inform the learners where they are, what they explored, and to what extent they explored. However, the reasons why they visited the nodes are not clearly shown.

Concept maps consists of the nodes and links representing the structure of domain concepts to be learned. Each node is mapped on the corresponding node in hyperspace. The scope where the learners have already visited in hyperspace is mapped on the corresponding part of the concept maps. The learners can look at the partial structure of the concept maps to reflect on what they learned in hyperspace [5]. Such maps are more helpful for learners who have lower capability of exploring hyperspace in a constructive way since the direction of knowledge construction is visible to them. However, learners who have higher capability of the exploratory learning may identify semantic relationships among the domain concepts explored in a self-directed way, which relationships may be different to those defined in the concept maps [12]. In other words, they do not always construct the same knowledge structure as the structure of domain concepts that the designers of concept maps make.

The interactive history, on the other hand, provides the learners with a more proper support since it enables self-directed exploration and generates a knowledge map according to their exploration process. In addition, the interactive history can provide the reflection support even for most existing web-based learning resources of which concept maps are not prepared and even in ill-structured domains of which concept maps cannot be defined.

4 Preliminary Evaluation

4.1 Experiment

In order to evaluate the interactive history system, we have had a preliminary experiment. The main purpose of this experiment was to analyze the utility of the system and to ascertain if the interactive history improves learning compared to learning without the system. We also prepared two web-based learning resources, which had comparatively simple and complicated hyperspace, and ascertained in which resource the interactive history system enhances its own utility and facilitates learning more effectively.

Table 2 shows the two learning resource, which describes the number of nodes, and the number of links per node, which was calculated except for navigation links such as *Next*, *Back*, and *Top*. These can be viewed as the indicators of the complexity of hyperspace each learning resource provides. The learning resource 2 accordingly had a more complicated hyperspace. Subjects were five graduate and undergraduate students in science and technology.

We set four conditions, which were (1) learning in the learning resource 1 with the system (*Simple-With*), (2)

Table 2. Learning Resources.

	Learning Resource 1	Learning Resource 2
Number of Pages	73	161
Number of Links per Page	1.2	2.2

Domain of learning resource1: Mechanism of earthquake
Domain of learning resource2: Life in Sea

learning in the learning resource 1 without the system (*Simple-Without*), (3) learning in the learning resource 2 with the system (*Complicated-With*), and (4) learning in the learning resource 2 without the system (*Complicated-Without*). Subjects were provided with Internet Explorer as WWW browser under each condition. In this experiment, each subject learned one learning resource with the system, and learned the other without the system. In other words, he/she was assigned two conditions, which were *Simple-With* and *Complicated-Without* (or *Simple-Without* and *Complicated-With*).

Before learning, subjects were given a learning purpose for each learning resource. Under *Simple-With* or *Complicated-With*, they were also given the explanation about how to use the interactive history system, and were asked to try it in a sample learning resource whose hyperspace is simple. They were then asked to explore hyperspace with or without the system to accomplish the learning purpose. After subjects finished learning, they were given several problems about the contents for each learning resource. The problems were classified into (1) single problems whose answers could be found within one WWW page, and (2) compound problems whose answers could be found in the relationships among two or three pages. In this experiment, effects on learning were measured by the scores on both problems. The utility of the system was analyzed with the dispersion of pages visited, the number of revisit per page [11], the number of primary exploration processes executed, and the number of revisiting pages that were included in the primary exploration processes. Comparing the averages of them under *Simple-With* and *Simple-Without* or under *Complicated-With* and *Complicated-Without*, we evaluated the utility and effectiveness of the interactive history system.

4.2 Results and Discussion

Table 3 summarizes the analysis of the utility. The average numbers of revisit per page on both *Simple-With* and *Complicated-With* were slightly higher than the average numbers of revisit per page on both *Simple-Without* and *Complicated-Without*. The average dispersion of pages visited on both *Simple-With* and *Complicated-With*, on the other hand, was lower than the average dispersion of pages visited on both *Simple-Without* and *Complicated-Without*. In particular, the difference between *Complicated-With* and *Complicated-Without* was large. These results indicate that the interactive history system makes learners' exploration more intensive, particularly in a more complicated hyperspace. We further analyzed the utility of the interactive history system on *Simple-With* and *Complicated-With* as shown in Table 4.

Table 4 shows the average number of primary exploration processes executed, the average number of starting and terminal nodes (pages), and the average number of revisiting pages that are included in the primary exploration processes. The average numbers of starting and terminal pages on *Simple-With* and *Complicated-With* corresponded to about half of the average numbers of pages visited as shown in Table 3 (56% on *Simple-With* and 52% on *Complicated-With*). In other words, half of the visited pages were related to the primary exploration processes. The average numbers of revisiting the starting and terminal pages on *Simple-With* and *Complicated-With* accounted for 67 % and 78 % of the whole revisits shown in Table 3. The ratio on *Complicated-With* was particularly high. These results indicate that the interactive history system can direct learners' attention to primary exploration processes, particularly in a more complicated hyperspace. In other words, the system can encourage learners to rethink exploration processes. This would improve learning.

Table 5 shows the average score of problem-solving on each condition. As for the single problems, the average scores on *Simple-With* and *Complicated-With* were lower than the average scores on *Simple-Without* and *Complicated-Without*. As for the compound problems, on the other hand, the average scores on *Simple-With* and *Complicated-With* were higher than the average scores on *Simple-Without* and *Complicated-Without*. In particular, the difference between *Complicated-With* and *Complicated-Without* were large. These results indicate that the interactive history system can produce good effects on learning such as integrating the contents of some nodes by means of exploration purposes, particularly in a more complicated hyperspace.

5 Conclusions

This paper has claimed that exploratory learning in hyperspace requires learners to reflect not only what but also why they have explored, and that the reflection support needs to adapt to their exploration process and knowledge structure being constructed by them.

This paper has also demonstrated the interactive history with knowledge mapping as a proper reflection support. The interactive history encourages learners to annotate and manipulate the exploration history to rethink their exploration processes. It also generates a knowledge map from the annotated exploration history, which allows the

Table 3. Analysis of Utility.

	Total Number of Pages Visited (a)	Number of Pages Visited (b)	Dispersion (b/a)	Revisit (a-b)	Revisit per Page ((a-b)/b)
Simple-With	69	19.5	0.283	49.5	2.53
Simple-Without	72	22.3	0.31	49.7	2.23
Complicated-With	67.3	21.3	0.317	46	2.16
Complicated-Without	59.5	32.5	0.546	27	1.25

Table 4. Utility of Interactive History.

	Number ofPrimary Exploration Processes	Number of Starting and Terminal Pages	Revisit
Simple-With	9.5	11(56%)	33 (67%)
Complicated-With	8	11(52%)	36 (78%)

Table 5. Avarage Scores of Problem-Solving.

	Total	Single Problems	Compound Problems
Simple-With	60.5%	75%	66.7%
Simple-Without	66.7%	91.7%	50%
Complicated-With	51.8%	55.6%	50%
Complicated-Without	41.1%	66.7%	25%

learners to reflect on what they have constructed during exploration.

In addition, this paper has described a preliminary evaluation of the interactive history system. Although we need a detailed evaluation with more subjects, the results indicate that the system facilitates a rethink on primary exploration processes particularly in a complicated hyperspace. The system can also improve learning, particularly integrating the contents of some WWW pages.

In the future, we will have a more detailed evaluation. We would also like to classify exploration purposes in detail to represent learners' exploration process more precisely.

Acknowledgments

This research is supported in part by Grant-in-Aid for Scientific Research from the Ministry of Education, Science, and Culture of Japan. We also want to thank Dr. Noriyuki Matsuda for his valuable comments for implementation of the interactive history.

References

[1] Brusilovsky, P. Methods and Techniques of Adaptive Hypermedia, Journal of User Modeling and User-Adapted Interaction, 6, (1996) 87-129.

[2] Chan, T.W., Lin, C.C., Lin, S.J., and Kuo, H.C. OCTR: A Model of Learning Stages, in Proc. of 6th World Conference on Artificial Intelligence in Education '93 (1993), 257-264.

[3] Conklin, J. Hypertext: An Introduction and Survey, Computer 20, 9 (1988), 17-41.

[4] Domel, P. WebMap - A Graphical Hypertext Navigation Tool, in Proc. of Second International WWW Conference (1994), http://www.ncsa.uiuc.edu/SDG/IT94/Proceedings/Searching/ doemel/www-fall94.html.

[5] Gaines, B.R. and Shaw M.L. G. WebMap: Concept Mapping on the Web, in Proc. of Second International WWW Conference (1995), http://www.w3.org/Conferences/ WWW4/Papers/ 134 .

[6] Kashihara, A., Hirashima, T., and Toyoda, J. A Cognitive Load Application in Tutoring, Journal of User Modeling and User-Adapted Interaction, 4, 4 (1995), 279-303.

[7] Kashihara, A., Kinshuk, Oppermann, R., Rashev, R., and Simm, H. An Exploration Space Control as Intelligent Assistance in Enabling Systems, in Proc. of International Conference on Computers in Education '97 (1997), 114-121.

[8] Kashihara, A., Uji'i, H., and Toyoda, J. Reflection Support for Learning in Hyperspace, Educational Technology, Vol.39, No.5 (1999), 19-22.

[9] Murray, T., Condit, C., Piemonte, J., Shen, T., and Kahn, S. MetaLinks - A Framework and Authoring Tool for Adaptive Hypermedia, in Proc. of World Conference on Artificial Intelligence in Education 99 (1999), 744-746.

[10] Nielsen, J. The Art of Navigating Hypertext, Communication of the ACM, 33, 3 (1990), ACM Press, 297-310.

[11] Tauscher, L., and Greenberg, S. How people revist web pages: empirical findings and implications for the design of history systems. International Journal of Human-Computer Studies, 47, 1 (1997), 97-137.

[12] Thuering, M., Hannemann, J., and Haake, J.M. Hypermedia and Cognition: Designing for Comprehension. Communication of the ACM, 38, 8 (1995), ACM Press, 57-66.

[13] Zeiliger, R., Belisle, C., and Cerratto, T. Implementing a Constructivist Approach to Web Navigation Support, in Proc. of World Conference on Educational Multimedia and Hypermedia '99 (1999).

Models and Strategies for Promotion of Distance Learning in Primary Schools and High Schools

Jia-Rong Jerome Wen * Chia Chin Li and Jian Jie Dung***
**jerome@nknucc.nknu.edu.tw   djj@icemail.nknu.edu.tw*
116,Ho-Pin 1st Road,Kaohsiung,Taiwan,R.O.C
***april@ficnet.net*

The information education in Taiwan has been progressing rapidly since the Network Technology was adopted on a large scale.Under the Nine-Year Consistent Courses policy the by Ministry of Education, the information education will be integrated into other subjects and all teachers need to use computer and Internet resources to assist teaching .The plentiful education web sites on Internet also provide the student with materials for assisting learning .The essay presents the development process of information Education in Taiwan ;through it, we point out the obstacles we meet when promoting information education in primary schools and high schools.Meanwhile ,through introducing two education web sites :Gas Station for Learning and Schoolfellows' English Adventure Land, which were constructed in different models ,we offer the workable models and strategies for promotiing distance education in primary schools and high schools.

Keywords: **Distance Learning, Nine-Year Consistent Coures ,Teaching Material Resources Center, Schoolfellows' English Adventure Land**

1 Introduction

1.1 Analysis of Current Situation

"Nine-Year Consistent Syllabus" implemented in 2001, all schools will no longer especially establish the subject of Information Education, but enlist it in the learning area of "Nature and Technology." Nevertheless, in order to train students to have the basic abilities to make use of technology and information, teachers have to emphasize the application of information in the teaching of different subjects. And all teachers of different subjects are expected to take computer as a tool of instruction, integrate via network the traditional teaching materials and the teaching materials on Internet, and provide students with broader and more diversified learning resources.[2][3]

1.2 Problems Faced by Distance Learning:

To apply information education to the teaching of various subjects will really be a consistent trend in the education of Taiwan in the future. However, when confronted with the important educational reform, the actual implementation encounters difficulties because of Taiwan's restricted environment for information education.

The ratio of the number of class computers to the number of the students of a class is such a wide gap.If teachers are requested to use the limited computer classrooms to apply information to the teaching of various subjects, obviously, it is not an easy job to promote this at the current stage.[5][7]

2 Distance Instruction and Distance Learning

After the Ministry of Education implemented "Foundation Establishment Plan of Information Education," the computer and network equipment of various schools are increased. Besides, it also promotes the establishment of "Information Education Software and Teaching Materials Resources Center" at primary schools, junior high schools, senior high schools and vocational schools, in order to enrich the network teaching materials for subjects of primary schools and high schools.[1][8]

Besides, the famous distance instruction network of primary schools and high schools in Taiwan is illustrated as follows (Table1):

Web Site Name	Address	Institute	Object
Gas Station of Learning	http://content.edu.tw	Ministry of Education	Grade 1 to 12 student
Schoolfellows' English Adventure Land	http://192.192.186.8/seal/	San Hsin Institute of Housework and Commerce	Grade 1 to 12 student
Pathfinder	http://pathfinder.ntntc.edu.tw/	National Tainan Teachers College	Grade 1 to 9 student
Computer Assisted Instruction	http://www.wcjs.tcc.edu.tw/	Wu Chi Junior High School	Grade 7 to 9 student
Teaching Resource	http://www.ctjh.tpc.edu.tw/ctjh/resource.htm	Chiang Tsui Junior High School	Grade 7 to 9 student

Table1: Virtual Classroom Web Site for Grade 1 to 12 student

3 Teaching Materials Resources Center Focusing on Systematic Subjects

3.1 Concept and Idea:

The Ministry of Education in Taiwan starts "Foundation Establishment Plan of Information Education" not only to establish hardware environment, train teachers, carry out promotion activities, etc., but also to establish Information Education Software and Teaching Materials Resources Center, simply called "Education Resources Center" or "Gas Station of Learning."(http://content.edu.tw)

3.2 Outline of Resources Center:

The Ministry of Education advises various school to develop the on-line teaching materials of different subjects. The center can effectively integrate the resources of all primary schools and high schools and develop a series of network instruction resources with its own characteristics. "Teaching Materials of Subjects" are divided into four divisions: primary school, junior high school, senior high school and vocational school. In each group there are: 14 subjects in primary school, 19 subjects in junior high school, 17 subjects in senior high school, and 21 subjects of 4 categories in vocational school (the divisions of senior high school and vocational school was established in January 2000). The information integrated and collected by web sites cover the education resources of the Chinese's Five Education: virtue, wisdom, physical, group and aesthetics.

Through a united interface of users, it decreases the learners' load in adaptation to learning environment. The establishment of "Education Resources Center" is expected to achieve the following objectives: [6]

- Strengthen the applied network resources for teachers and students, and make the educational environment more diversified .
- Lay a foundation for a lifelong learning environment.
- Strengthen the quality and quantity of the resources of information learning so as to reach the aims of sharing of resources
- Shorten the distance between city and village [1]

4 Schoolfellows' English Adventure Land Focusing on Self-Learning

4.1 Concept and Idea

Teaching Materials Resources Center mainly edits the teaching materials according to the contents of the systematic teaching materials of various subjects. Therefore, they are suitable for teachers to adopt in class and for students to review after class. However, in the age of information explosion, the knowledge in books can no longer satisfy most of the students' thirst for knowledge. Therefore, with network being the media, distance education must have more diversified contents. It also has to create an interacting relationship between school and students. It can hold various kinds of activities and offer substantial awards to encourage all the students to participate. Then an activated distance learning environment can be created beyond system. Kaohsiung municipal government is positively involved in the activity. The "Schoolfellows' English Adventure Land , SEAL "(http://192.192.186.8/seal/) established by the municipal government at San Hsin Vocational School is based on this idea. It has the following characteristics :(1)Diversified Contents and Scope.(2)Individualistic Learning Environment.(3)Internet Learning without Limitation of Time and Space. (4)Flexibility of Time, Holding of Activities.(5)On-Line Contest,Internet Pen Pal Society.(6)Teacher Mechanism--Student Groups Management and Inquiry of Students' Learning Process:,Self-Made Test Paper Management:

4.2 Evalutaion on SEAL

The working group of Seal held an investigation in December 1999, towards the junior and elementary school teachers that used this website to assist their teaching. The questionnaire adapted Likert's five point scale from extremely disagree(1) to highly agree(5). In the 73 effectively retrieved questionnaires, there're 67 English teachers and 6 are not English teachers.

The statistics results of the questionnaire, in the curriculum arrangement and management session, show that sample teachers think the arrangement of the curriculum in SEAL is appropriate and the related activities that go with the curriculum is successful. (M=4.10 ,SD=0.82)。Sample teachers think that the recording of learning profile on the website of each student helps teachers to understand the student's learning style and problems.(M=4.26,SD=0.83)。Sample teachers think that the idea of designing language games and holding on-line composition contest is appropriate. (M=4.16,SD=0.83 ;M=4.03 ,SD=0.93)。About the learning interaction, most teachers thinks that English pen pal club will help to enhance the interaction between students, M=4.18 SD=0.93) . Most teachers think that SEAL is worth popularizing in assisting traditional learning. (M=4.59,SD=0.66)。

5 Workable Model and Strategy

In the implementation of distance education in primary schools and high schools, besides the consideration of the contents of teaching materials, how to make use of the characteristics of Internet appropriately to activate instruction is an important topic that cannot be neglected for discussion. Focusing on the above-mentioned analysis, we propose a model and strategies for distance learning be carried out in primary schools and high schools:

5.1 Four Elements for Activating Web Site:

According to the discussion above,there are four elements to activate the web site teaching materials :the content, interactivity, learning profile and activity. We have to take these four elements into consideration when designing the learning web site. The detailed function of the four elements is as follow:

5.1.1 Content

Text, image, sound , photo , animation chip and other mutimedia components should be included in an excellent education web site.Through multiple information styles supplied , the student can obsorb knowledge easily

5.1.2 Interactivity

With more interactivity function the education web site is more attractive and effective .The interactivity machanism encourages the student to use higher -level cognition skill..

5.1.3 Learning Profile

The learning profile lets the student know what he has learned and what to learn .The porfile also provides the teacher information about the student.

5.1.4 Activity

Not only in classroom but also in virtual classroom, well-designed activities are very important to improve the effectiveness of learning . Besides, through holding an activity , the student can cooperate and compete with others .

5.2 Strategy for Promoting Distance Learning

From this point of view, we will suggest applicable strategies for school administrators,teachers and students.

5.2.1 As for school adminstrator:

∗ Establishment of Web Site by Full-time Professionals:
The school administrator should know there should be full-time professionals to put teaching materials on Internet, hold Internet activities and carry out the maintenance work of systems.

∗ Strengthening of Propaganda:
The education departments or general affairs units of schools should positively introduce such an environment in the learning of students, and positively hold activities of relevant kind.

5.2.2 As for teacher and related professional:

∗ Development of Excellently Activated Web Site:
A web site must have substantial contents , diversified activities as well as interactivity machnism and learning profile to make the web site become a dynamic and lively learning environment.

∗ Material Making:
Teachers need not learn the establishment of web site. Teachers' job should be an all-effort studying of suitable contents of teaching materials for the learning of students.

∗ Resource Assisted Teaching:
All the related teaching web sites need the teacher to use them .Many web sites are well constructed ; however,few teachers use it to assist teaching . The teacher can provide the web site constructor with feedback for promoting the funciton or the rescources of the web.

5.2.3 As for Students:

∗ Participate in activities :
Only students' participation can make web sites activated and meaningful; otherwise, web site is merely an empty shell in a waste of information development.

∗ Resource Assisted Learning:
The student can make good use of on-line material to assist learning after class ; meanwhile , the student's feedback also helps the web constructor refine the web .

6 Conclusion

After the implementation of "9-year consistent" new syllabus in primary schools and junior high schools, information will be applied to various subjects and the application of network resources will become broader. The information-application-oriented network learning functions can be facilitated more effectively. The "Plan of Teaching Materials Resources Center" undertaken by Ministry of Education integrates various schools' resource to establish a garden that provides teachers with instruction resources and students with learning resources.The Plan not only can reach the purpose of resources sharing, but also decrease the load of learning through united interface environment. Besides, the distance learning environment beyond system, as provided in "SEAL," is also a good example for primary school students and high school students to involve in distance learning.

In term of positive implementation of information education, it is important to cooperate with the existing instruction environment and choose a workable model. For the government, based on the principle of effective utility of resources, it is necessary for her to integrate the establishment and the sharing of instruction resources. For schools, they have to encourage teachers and students to use Internet positively to assist in their teaching and learning. For teachers, they might not be required to allocate teaching materials on Internet, but they have to use the existing Internet resources and teaching materials positively, adopt suitable instruction methods, and correctly use Internet to communicate with students or parents. For students, they should meet the instruction of schools, use the teaching materials on Internet to assist in their learning, and learn new knowledge themselves.

References

[1]Bates A.W.,"Technology, Open Learning and Distance Education",Routledge. (1995)

[2]Chin Nian-Shing , "The World Wide Web Integrated Learning Environment", Information & Education ,vol 64, Taichiung Home Economical and Commercial Vocational School . (1998)

[3]David H. Jonassen:,"Computers in the Classroom: Mindtools for Critical Thinking", Prentice-Hall. (1996)

[4]Hung Ming-Jou,"Teaching On Internet", Hua-chai Software. (1999)

[5]J. Mark Pullen (1999):Synchronous Distance Education and the Internet. George Mason University.

[6]The Preface of "Gas Station of Learning,http://content.edu.tw/new/intro1.htm(2000)

[7]Wang Chuan-Shi: "Experimental Research on Adoption of Information Technology in Subject of Chinese Language at Primary School.",Research Plan of Graduate School of Information Education of National Kaohsiung Normal University, unpublished.

[8]Wang Wen-Ke,"Research Approach of Education (new ed.)", Taipei City: Wu Nan. (1999)

Multimedia Whiteboard Design in* WWW-Based Remote Cooperative Education System

Xueli Yu, Zongxia Du and Shiping Li
Taiyuan University of Technolygy, Taiyuan, Sahnxi, PRC
E--mail: xlyu@tyut.edu.cn

Computer Supported Cooperative Work (CSCW) is combined into the remote education, and the WWW-based Remote Cooperative Education System (RCES) is designed and realized in the paper. RCES adopts Browser/Serer model and makes users be able to run the client over the Internet without the need of installing special client software. And the real-time communication tool in RCES - multimedia whiteboard is also designed and realized which is also the major tool of CSCW. A set of Control Transport Protocol (CTP) is proposed to transmit the data and realized with Java and Java Media Framework (JMF). The new system enhances the interaction capability and realizes live transmit of multimedia data including graphics, images, audio and video etc.

Keywords: **CSCW, RCES, CTP, whiteboard**

1 Introduction

The theory of Computer Supported Cooperative Work appeared along with the progress of society, development of science and technology and raise of the complicated level of work. It provides a "being face-to-face " and What You See Is What I See (WYSIWIS) environment for the users scattered on different time and in different space and makes it possible for computer system to raise group work efficiency as well as traditional individual work efficiency. Since Engelbart first demonstrated CSCW in the 1960s, a variety of CSCW applications have developed at several research laboratories and universities. Education is an inherently cooperative activity involving at least one teacher and one student. Now, we combine CSCW into remote education, design and realize the WWW-based Remote Cooperative Education System (RCES). It adopts Browser/Server model and makes users can run the client over the Internet without the need of installing special client software.

Whiteboard is an important tool in the WWW-based RCES. The whiteboard provides a real-time interactive environment among people. In the traditional education, teacher and students face to face exchange their opinion through blackboard in classroom. While in the WWW based RCES on-line exchanging opinion and consulting are fulfilled through whiteboard over the Internet. Except the basic function, the whiteboard adds some functions such as drawing, loading images etc. The existing whiteboard system can roughly be divided into two kinds: systems based on Client/Server model and systems based on Browser/Server model. The whiteboard based on C/S model can solve well the interaction problem and provide powerful function for users. Its defect is that the users have to install the client software as server does. That limits the application scope of the system. Compared with it, the whiteboard based on B/S model can run over the Internet and the client doesn't need special software, but a

---

*Supported by the Foundation of Returned Overseas Students and Scholars in Shanxi Province browser such as IE or Netscape navigator is needed. Apparently B/S model gives a more convenient environment to the users. But its interactivity is less than C/S model and most present whiteboards based on B/S model only transmit the information such as texts, graphics, images, but do not support the transmission and playback of the time-based information such as audio and video.

We design and realize a new real-time communication tool in RCES—multimedia whiteboard that is also the major tool of CSCW. It absorbs the advantage of systems mentioned above. New system adopts B/S model and makes users can run the client over the Internet without the need of installing special client software. In addition, we design a set of Control Transport Protocol (CTP) in order to transmit the data and implement it adopting Java and Java Media Frame (JMF). Compared with the present whiteboard, the new system enhances the interaction capability and transmits multimedia data lively including graphics, images, audio and video etc. And the live audio and video can be transmitted and played back on this new whiteboard to make the system more practical.

2 Control Transport Protocol Design

TCP/IP and UDP are the major protocols of the Internet and they are well supported by Java. The multimedia whiteboard runs over the Internet, so the system is mainly based on TCP/IP. When multimedia information is transmitted, Real-time Transport Protocol (RTP) is used, which is a protocol based on UDP so as to get better playback effects. In order to transmit and deal with the system information over the Internet, we design a new control protocol of application layer—Control Transport Protocol (CTP) that is special for the whiteboard system. We design it on the basis of the whiteboard function and build it in the request/response model.

Owing to assuring the accuracy of data transmission by TCP / IP, therefore, the design of CTP should be as succinct as possible under the promise that the function is guaranteed.

The CTP set can be represented as a multi-element set (D, F, n, a_1, a_2, … a_n). Here D represents the transfer direction. If data is transmitted from server to client, and then D="S", whereas D="C"; F represents the catalog of transfer data. For example, if a user wants to transmit the login data, and then F="login"; n represents the number of associated information and the concrete associated information is represented by a_1, a_2, … a_n. For a line, n=6, a_1="line", it is one of graphics styles. a_2 =color of paintbrush, it is an integer, a_3, a_4, a_5, a_6 are the starting and end point coordinate of this line. If the number of associated information is uncertain, and then n=-1, the subprotocol is ended with "ok". This protocol set can be expanded easily. For example, we want to transmit the polygon, we can add ("C","polygon", -1, the color of paintbrush, abscissa of starting point, ordinate of starting point, abscissa of the second point, ordinate of the second point, …abscissa of end point, ordinate of end point, "ok") to the CTP set.

Table 1 Control Transport Protocol Set

Tasks	Protocol
User applies* to join in a discussion room	("C", "join", 1, the topic of discussion room)
User applies to pause the communication	("C", "pause", 0)
Server demands** to refresh the room and the user lists	("S", "refresh", -1,the topic of room 1,the user 1's ID in the roon $_1$,e the user 2's ID in the room $_1$, "complete", the topic o room $_2$,e the user 1's ID in the room $_2$ …"complete", the topi of room $_n$ the user 1's ID in the room $_n$,"complete", "ok")
User applies transmit the graphics	("C", "draw", 6, graphics style***, the color of paintbrush, ab scissa f of starting point, ordinate of starting point, abscissa o end point, ordinate of end point)
Server demands transmit audio data	("S", "audio", 1, IP Multicast address)

Note: * The data from client is transmitted to server only;
** The data from server is transmitted to all clients in the same room;
*** The style of graphics includes line, point, oval and rectangle etc.

3 The method of solving key problems

The whiteboard is a major tool to help the cooperative education system to fulfill the cooperation. We have solved the key problems including technical problems about CSCW, problems occurred during multimedia transfer and so on. The method of solving key problems in the whiteboard is described as following:

1) The method of solving CSCW technical problems in the whiteboard

CSCW technical problem generally includes role-control, data consistency, conflict clearing, concurrency control and so on.

① Role control
Every user who logs in the system will play a role. In the education system, users are divided into 2 class: Teachers and students. By means of User ID, users get their roles and authority from existed user information database soon after they log in. Then according to their different roles and authority, related system functions are given.

② Data consistency
We use the method of Client/Server to solve the problem of data consistency. The whiteboard server maintains a set of global data and the data on each client PC are same as those on the server. When users operate with the data on client PC, this PC sends message to the server first. The server updates the global data and then informs the clients of the modification. At last, the clients update local data to keep the coherence of the whole system.

③ Conflict clearing
The conflicts in whiteboard mainly refer to data resource conflicts during transfer. They are due to the limited bandwidth and the high frequency outburst during data transfer. When several users send data at the same time or a certain user sends a mass of data, the congestion will occur in the web. Hence, data may be discarded or errors may be caused. Further, valid data have to be sent again and the congestion will be more serious. This problem is solved by way of data priority (PRI) when designing the system. That is to send the vital data first. Data PRI can be divided into 5 levels. They are listed in orders from higher to lower. i) Data such as users login information or screen-refreshing data, because these data will influence all users; ii) texts and graphics; iii) images; iv) audio; v) video. Data in higher level are always sent first.

④ Concurrency control
Concurrency control mainly indicates the conflict of shared resource used by users at the same time. Solving this problem is very important to fulfill cooperation; this factor must be taken into account in. Because the system belongs to distribute one, hence the concurrency control is very complex. Typical method of dealing with concurrency is the locking or time stamp. Relatively, the former is more simple and valid. The method of locking is adopted in the paper.

In our Server/Client system, synchronous block is created in each subprotocol of the protocol set. All operation of the subprotocol is performed in its synchronous block, so as to limit output stream or input stream that accesses to the web at random. As a result, when a thread processes a subprotocol, it can monopolize the shared resource and the other threads cannot access the resource. Thus a thread is able to process a subprotocol without disturbance from the other threads and system error can be avoided. The disadvantage is that efficiency of thread operation will be decreased. So the code in a synchronous block should be limited as little as possible under the promise of correct subprotocol operation.

2) The method of solving problems in the multimedia transfer

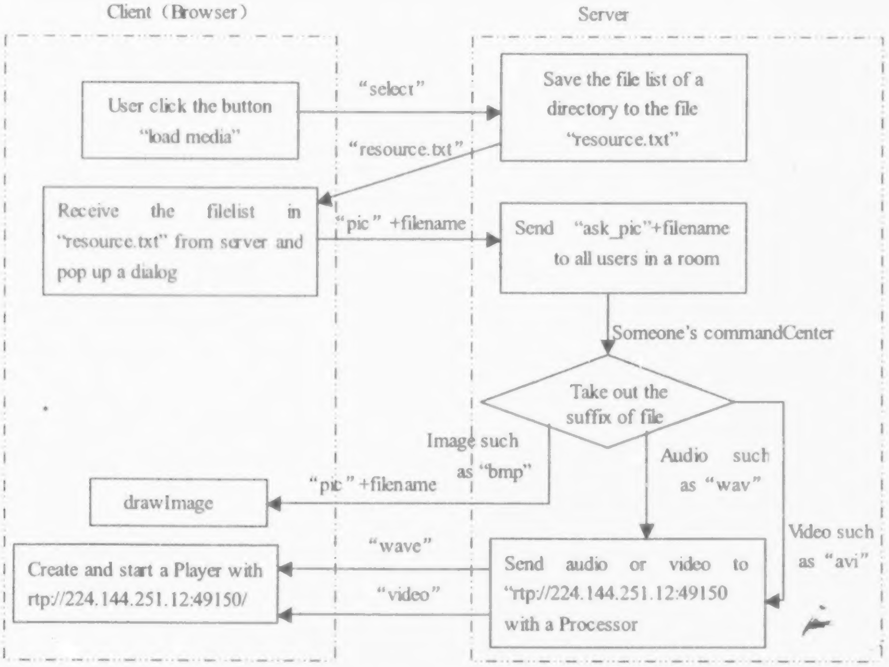
Multimedia information can be divided into 2 classes. One is information irrespective of time, such as text and graphics. The other is time-based information, such as audio and video. Because audio or video restrictively demands real time, discarding errors and ignoring lost data will achieve better effects. So audio and video information are transmitted by the way of UDP-based real-time transport protocol----RTP. It provides real time media transport services, such as live audio or video. These services include data type, sequence number, time stamp and transfer supervising. In fact, RTP itself cannot fulfill data-transmitting service without the help of protocols in lower level of the networks. The head of each RTP data packet includes time stamp and sequence number. With the time stamp, the receiver can resume the original data sequence. With the sequence number, the receiver can deal with lost, repeated or error data packet.

On the other hand, because the audio or video information is usually a large amount, and needs long time to transfer, it will take up too high bandwidth. In the situation of multi-users over the Internet, the method mentioned above cannot achieve good effects. We take advantage of IP Multicast Technique to save bandwidth, and the transferring and playing back audio or video smoothly in narrower bandwidth can be realized. IP Multicast Technique is a complement to the standard protocols of network level. It uses D-Class IP address that possesses the same byte length as A-Class, B-class or C-Class address. And the scope of D-Class address is from 224.0.0.0 to 239.255.255.255 in decimals.

D-Class address is a kind of temporary address that is assigned and recovered dynamically. Each multicast group is corresponding to a dynamic D-Class address. After the multicast group finishes, its related D-Class address will be taken back to be used later. D-Class IP address is the multicast address for a whole group and the members in this group share the same D-Class IP address. So the information from the source node is sent only to members in this group. Furthermore, only one packet is sent to the site on the same route and the action of copying is performed only when needed. This process is different from point-to-point system (in point-to-point system, each destination site needs a copy). So we are able to save lots of bandwidth resource, increase the members on networks and eliminate the aimlessness of broadcast with the multicast way.

Because the standard JAVA API doesn't support transfer and playback of video information, the Java Media Framework produced by Sun Company can be applied. In fact JMF is a group of Java class library, which is created specially to remedy the incomplete support to multimedia in Java. JMF collects and plays multimedia data in Java applications or Java applets. JMF itself supports both RTP and IP Multicast Technique, so it is very convenient to transmit and play audio or video back with JMF.

4 Multimedia information flow



Client (Browser)
Server
User click the button "load media"
"select"
Save the file list of a directory to the file "resource.txt"
"resource.txt"
Receive the filelist in "resource.txt" from server and pop up a dialog
"pic" +filename
Send "ask_pic"+filename to all users in a room
Someone's commandCenter
Take out the suffix of file
Image such as "bmp"
Audio such as "wav"
Video such as "avi"
"pic" +filename
drawImage
"wave"
"video"
Create and start a Player with rtp://224.144.251.12:49150/
Send audio or video to "rtp://224.144.251.12:49150 with a Processor

Fig.1 Multimedia information flow

Multimedia information flow is as shown in the figure 1. Taking the example of transmitting loaded multimedia information, the system flow is given out while users discuss using the whiteboard. When a user wants to load multimedia on the client, the client will send message ("C", "select", 0) to the server, which indicates the user wants to select loaded files. On receiving this message, the Sever sends a file list that is stored in a file named as "resource.txt" to the client. Then the client reads the file list out of that file and displays it in a new file-selecting dialog box. Hence the user can select the file that he wants to load and the message ("C", "pic", 1, filename) is sent to the server.

After the server receives this message, it sends the message ("pic"+ filename) to every user object that belongs to the server. Please note that this message is sent not to the client side but to the related user-information object in the server. According to the suffix of the file, the server knows it is an image, an audio or a video file that is needed by the client. If a picture is wanted, a message ("S", "pic", 1, filename) is sent to the client and the client calls drawImage () function to present the image by its filename. If the audio or video is wanted, the Server will create a D-class multicast address and send multimedia data to this address. Meanwhile the Server sends to each user in the room a message "audio"(in case of audio data) or a message "video" (in case of video data). Thus the clients are informed to join in the related multicast address so that the audio or video can be played back.

5 Conclusions

In order to test the performance of new system, we not only apply text, image, animation, and drawing graphic, but also apply most challenging time-based media – audio and video – to this system. The result is rather good (Testing condition is: rate of network is over 40 Mbps, one server and 5 concurrent users, on-line transferring and playing back audio and video).

Remote education is an application on networks that develops rapidly in recent years. With the never stopping development of network technique and multimedia technique, the users' demand on remote education will be higher and higher. We combine CSCW technique into remote education and make the system possess more and better mutual functions. Based on the past man-to-PC mutual mechanism, we add man-to-man mutual mechanism to the system. Now the educating process becomes more vivid, and better education effect is achieved.

The real-time communicating ability of most B/S model software in present cannot satisfy the users' demands. Taking this factor into consideration, we design and use CTP to transmit control message and non-time-based media information and combine RTP and IP Multicast Technique with CTP to fulfill the transfers and playback of multimedia information. Hence the real-time communication ability of the system is enhanced. Compared with the present whiteboard in B/S model, the system has stronger function in transmitting the multimedia. It can't only transmit the audio and video in files, but also can transmit the live audio and video to get better effects in education. The students can hear or see the teacher and communicate with him or her in real time.

Though most present software in B/S model are weaker than those in C/S model, the convenience that they possess provides a large latent market. Furthermore, with the development of the browser and other related techniques, the functions of software in B/S model will become more and stronger. In a word, the prospect of software in B/S model is promising.

References

[1] Liang ,Ting-Peng. When Client/Server Isn't Enough: Coordinating Multiple Distributed Tasks, Computer of IEEE, May 1994

[2] Mohammad Banikazemi. IP Multicast: Concepts, Algorithms, and Protocols http://src.doc.ic.ac.uk/computing/internet

[3] Nathaniel S. Borenstein, Computational Mail as Network Infrastructure for Computer-Supported Cooperative Work, Proceedings of CSCW 92, 1992, pp 67-74

[4] RTP: A Transport Protocol for Real-time Applications, RFC1889 http://src.doc.ic.ac.uk/computing/internet/rfc/rfc1889.txt

[5] Teege G. Object-Oriented Activity Support: A model for Integrated CSCW System. Computer Supported Cooperative Work. 1996, 5

Navigation Script for the World Wide Web

Sachio Hirokawa*, Kengo Nishino and Daisuke Nagano*****
** Computing and Communications Center, Kyushu University,*
**E-mail: hirokawa@cc.kyushu-u.ac.jp*
*** *** Graduate School of Information Science and Electrical Engineering,*
Kyushu University
***E-mail: Kengo.Nishino@ma3.seikyou.ne.jp*
****E-mail: nagano@matu.cc.kyushu-u.ac.jp*

In the World Wide Web, there is rich material for education. We propose a language to navigate students through the educational material on WWW. Navigation script makers can describe a tour with sequential, parallel and selective controls. It supports multiple Threads where video and audio accompany a browsing window. The language is described with XML and implemented in Java. So, the system can be used as an applet and as an application.

Keywords: **Hypermedia navigation ; Web graph ; XML ; JAVA**

1 Introduction

In the World Wide Web, there is rich material for education. For example, many university teachers give the contents of their lectures as their homepages. This paper describes a system which utilizes internet resources as educational material and makes them into an organized tour. The tour is described in a script language and an interpreter program navigates students through the material on WWW. Students are navigated automatically and interactively while they browse html-files and listen to and watch continuous multimedia.

We need to collect necessary pages from web resources containing a lot of garbage in order to make lists of URLs for our educational purpose. It is important to have students understand the relation between the collected pages and grasp the whole view of the field. When they do not understand the relation, or when they forget how they arrived the page, they feel that they got ``lost in webspace". There is a proposal of using web graphs as imaginary map of WWW[3]. A web graph is a directed graph whose nodes are URLs and whose edges are links between URLs. The web graph is more intuitive than just a list of URLs. But a web graph is nothing but a static representation of WWW. There is no mechanism how to lead students with material on the graph. There is no dynamic process to navigate them. We propose a script language that describes the navigation of WWW.

Maps are useful for navigation of real world and for navigation of WWW. For example, the page of Mapion http://mapion.co.jp/ shows geographic maps of towns. Besides, ``car navigation systems" based on GPS are becoming popular. RWML[5] and NVML[6] are proposal to combine the geographic map and the information on WWW. NVML describes the driving course, distance, time and supplies messages and images for specified points. When the car passes the point, a message and a image will appear according to a signal from GPS. The main concern of these researches is in geographic maps and navigation in real world. The maps we consider are imaginary maps of internet resources. Our goal is to design a language to describe a tour of WWW and to implement an interpreter of the language.

Ariadne[4] is a system of WWW navigation. It has a browser window and a separate window of tour. A user views the map of the tour and can proceed forward, backward and can choose if there are branches on the tour. But user needs to control every step of navigation. Our system supports both interactive and automated navigation. Another feature of our system which lacks in Ariadne is the parallel navigation. In our system, while a user is watching a browser window, another navigation thread can play audio data.

WebOFDAV[1] is a visualization system of web graph. When a user is traversing a series of URLs, the system draws the local graph of visited pages. The graph changes dynamically following the user. WebOFDAV is useful to tell where we are on WWW and powerful to get rid of the problem of lost in webspace. But the graph is used only for an aid for browsing and no navigation route is provided.

The rest of paper is organized as follows. The section 2 analyses the basic feature of navigation of WWW. The section 3 describes the navigation script using XML and explains the visualization of the scripts. The section 4 introduces a virtual machine with two stacks, which enables forward and backward navigation. The section 5 summarizes the paper.

2 Navigation Script

The most important feature of the navigation system is to guide the user around web pages in specified order. Therefore, we adapt sequentiality into navigation language. And to make the contents of html-files easier to understand, we need to combine audio, video, and images together with the usual browsing window. We introduce parallelism. To increase the variation of the navigation depending on each visitor, we add selection mechanism in the language. We design the language as a structured programming language with sequential, parallel and selective controls. The basic navigation units are multimedia data specified as URLs.

We chose XML as the description language of the navigation for simplicity and extendability. As implementation language we chose Java. We use ``XML Parser for Java"[2] for XML parser,and ``JMF"[7] for multimedia data. We describe the language as the following DTD (Document Type Definition).

```
<!ELEMENT statement (simple|sequential|parallel|select)>
<!ELEMENT simple (message)>
<!ATTLIST simple kind CDATA #REQUIRED
   target_name CDATA #REQUIRED
   play_time CDATA #REQUIRED
   delay_time CDATA #REQUIRED>
<!ELEMENT message (#PCDATA)>
<!ELEMENT sequential (simple|sequential|parallel|select)*>
<!ELEMENT parallel (simple|sequential|parallel|select)*>
<!ELEMENT select (selector)+>
<!ELEMENT selector (simple|sequential|parallel|select)>
<!ATTLIST selector selectname CDATA #REQUIRED>
```

Each tag and parameters have the following meaning.

- <statement>: This tag represents the root of navigation tour. It may contain subtours as children. There are four kinds of tours,<simple>,<sequential>,<parallel> and <select>.
- <simple>: This is the basic unit of the navigation. It contains a few lines of messages to describe the contents of the web page. It has the attributes of kind, target name, play time and delay time. Target name specifies the URL of the data. The kind describes the kind of multimedia data. Play time is the duration time and delay time is the time to wait before play.
- <sequential>: It may contain subtours of the kind <simple>, <sequential >, <parallel> and <select>. Subtours are followed consecutively.
- <parallel>: It may contain subtours of the kind <simple>, <sequential>, <parallel> and <select>. Subtours are activated in parallel.
- <select>: This tag causes a pause of the system. User can choose the navigation selectively from the given subtours. Those subtours are provided as children with the tag <selector>.
- <selector>: It may contain a subtour of the kind <simple>, <sequential>, <parallel> and <select>. It has the selectname as an attribute, which is used in the select menu.

3 Navigation Window, Control Panel and Browsing Window

Fig 1 is a screenshot of the system, which has a browser window, a quicktime movie screen, the controller screen and the window of navigation script.

We chose the representation with nested boxes for the visualization of navigation script instead conventional DOM-tree of XML nodes for several reasons. The most important feature of the navigation is the flow of time. To visualize this, we draw the subtours of a sequential tour from left to right. In Fig 1, time goes horizontally from left to right. Parallel tours and visualization of selection are placed vertically. The difference is that each subtour of the selection has its name, specified with its selectname, and the order in the choice. For example, if a selection has three choices, the second subtour is displayed as ``2/3 selectname".

Visualization of navigation script is not only for static view. It has a control panel and user can go forward and backward along the navigation. When a node is displayed on the browser window, the node in the navigation window is highlighted. So, the user has always global view of the navigation.

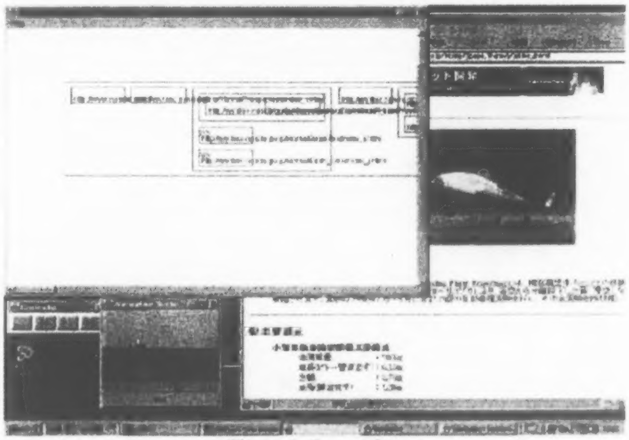


Figure 1: Screenshot

4 Interpreter of Navigation Script

Navigation is performed according to the kind of statement. Parallel statement opens a new browser window and a different thread performs the navigation in parallel.

The interpreter has two modes, the fully automatic mode and the interactive mode. Basically, the interpreter displays the specified html-files on the browser window. It displays the html-file on the screen for "play time" and changes to the next screen. When the user wants to see in detail, he can make a pause. He can go backward as well. The controller interacts with the user. The functions of the controller are "pause", "play", "forward", "backward", "rewind" and "stop". The "play" and "pause" toggles the mode. The "forward" and "backward" are for interactive mode. The browser screen moves one step in the sequential statement. This control is different to the controllers of multimedia players for the continuous media.

To realize forward/backward control in the navigation, we use two stacks of statements in the interpreter. The first stack "do"contains the list of statements to follow. The second stack "done" contains the list of statements already performed. The interpreter is realized by a transition of states depending on the top of the two stacks.

4.1 Forward Transition

Due to the limit of space, we only explain the forward transition concerning to parallel statement. If a parallel statement contains substatements, the interpreter creates n-1 threads which begin execution with ``done" stack empty and whose "do" stack contains the substatements. For example, a parallel statement "<parallel>a b c</parallel>" creates two new threads(Fig 2).

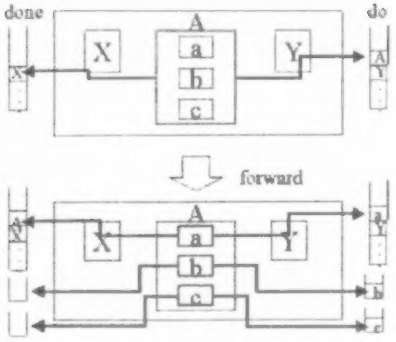


Figure 2: Forward Transition for Parallel Statement

4.2 Backward Transition

In the backward transition, the interpreter pops the statement at the top of ``done" stack and pushes it on "do" stack. If it is a sequential statement, then all the substatements are poped out of the "do" stack. A situation, where the "done" stack is empty, occurs only after a forward transition of a parallel statement. To go backward from such a situation, we need to delete such threads activated by the parallel statement.

5 Conclusions

We proposed a language for the navigation of WWW and described its implementation. The material of a navigation tour is web pages and multimedia data on WWW. The navigation script is defined as DTD of XML. Anyone can create a dynamic navigation from a static list of URLs. The language supports multimedia data and provides sequential, parallel and selective constructs of the tour.

References

[1] M. L. Huang, P. Eades, R. F. Cohen, ``WebOFDAV -navigating and visualizing the Web on-line with animated context swapping", Proceedings of 7th international WWW conference, Computer Networks and ISDN Systems, Vol. 30, no. 1-7, 638-642, (1998).

[2] IBM, ``XML Parser for Java", http://www.alphaWorks.ibm.com/tech/xml4j/(accessed on August 9,2000).

[3] D. Ikeda, T. Taguchi, S. Hirokawa, ``Developing a Knowledge Network of URLs", Proceedings of Discovery Science '99', Springer Lecture Notes in Artificial Intelligence Vol. 1721, 328-329, (1999).

[4] J. John, A.T. Jensen, K. Geronbak, ``Ariadne:a Java-based guided tour sys-tem for the World Wide Web", Proceedings of 7th international WWW conference, Computer Networks and ISDN Systems, Vol. 30, no. 1-7, 131-139, (1998).

[5] RWML Working Group, ``Road Web Markup Language (RWML) Draft Ver.0.71a (in Japanese)", http://www2.ceri.go.jp/its-win/RWML/RWML-071.html (accessed on August 9,2000), (1999).

[6] M. Sekiguchi, K. Takayama, H. Naito, Y. Maeda, H. Horai, M. Toriumi, "NaVigation Markup Language (NVML)", submission to the World WideWeb Consortium, http://www.w3.org/TR/NVML(accessed on August 9,2000), (1999).

[7] Sun Microsystems, ``Java Media Framework", http://java.sun.com/products/java-media/jmf/2.0/index.html (accessed on August 9,2000).

Networked Constructive CAI System Putting Emphasis on Communication and Discussion–An Example of Proportion-concept in Mathematics of Elementary School

Pou-Yah Wu*, Yi-Ling Lu, Ruey-Chuan Wu, Hsiao-Yun Wu and Shin-Pey Chen**
Department of Mathematics Education, National Tainan Teachers' College, Taiwan
E-mail: *pywu@ipx.ntntc.edu.tw **a8817209@wwes.tnc.edu.tw

New courses in mathematics of elementary school in Taiwan emphasize constructive pedagogy about solving problems, reflection, studying and learning, communication and discussion. The development of computer technology provides the environment of discussion, facilitating the convenience for communication. This study adapts itself to the change of teaching material for new courses, establishing connection by the operation of lineal graph. As far as the system is concerned, via elucidating the process of solving the problems, the system attain the effect of reflection; it establishes the virtual students and room for on-line discussion to achieve the aims of studying and learning, communication and discussion; letting the platform to the students to fulfill the concept of constructive pedagogy. After the future leased network become more popular and the computer interfaces become more humanized, we believe that the effects of communication and discussion will become better. Besides, the norms of discussing the order in this system will leave much to be desired.

Keywords: **CAI, mathematics of elementary school, proportion concept, Web-based learning.**

1 Introduction

New mathematics courses of elementary school in Taiwan adopting constructive pedagogy in 1993, thinking that the learning of mathematics knowledge is cultivated gradually in the processes of solving the problems, reflection, discussion and modification. Mathematics' meaning is formed individually, but the accumulated thoughts of the wholly social mass and cooperation can provide the best learning environment of mathematics. We hope that we can provide the learning environment of mathematics from the accumulated thoughts and cooperation by means of the networked constructive learning environment. The constructive pedagogy of new courses aims at the communication and discussion between the students[1]; however, communication and discussion waste much time. Thus, there is deficiency of time in teaching in the real pedagogy; nevertheless, the discussion of the virtual students and networked on-line learning can well make up the limitation of time and space, owing to the fact that the learning activities can be carried on at any moment and at any place through the network. The need of clarifying the concepts to communicate and discuss between emphasized by new courses can also come true. This study aims to associate the virtual students and networked learning, designing networked constructive learning environment, providing a environment for communication and discussion, helping students construct the concept of proportion, letting the communication can be undertaken immediately between the learners, between the learners and the virtual students, making up a wholly cooperative learning environment, thereby facilitating the students to clarify and to develop mathematics concepts.

2 Principles of System Construction

2.1 Basis of Learning Theory

Constructive pedagogy let the students establish his conceptual structure with new things; the teacher helps the students construct knowledge only. Thus, the teacher plays the role of posing the problems; the real solver of the problems is the student. Basically constructivism stresses the concept of learner-centeredness. With a view to fulfilling the educational ideal of child-centeredness, new courses emphasize the students' natural thought and the individual difference[1]. Why the students' natural thought be stressed? Because the learner has to construct knowledge positively, and he constructs the knowledge on his own natural thought. To adapt the various natural thoughts, in addition to "time difference" of the individual difference in the process of the students' learning, the so-called "route difference" is added [3]. Thus, the learner may adopt different ways of solving problems to form various records. New courses stress the activity of solving problems and reflection to accumulate related experiences of activities to serve as the foundation of upholding mathematics knowledge. Thus, the issued culture within the class in the lower grade courses, then, emphasizing discussed culture in classes of higher grades, partly discussing students via classes, and partly reflecting his own thoughts about solving questions[1].

2.2 Basis of Course Content

Old courses in 1975 emphasize the processes manifested; therefore, what the old courses lay stress on the proportion concepts is the exercise of the abstract meaning on ratio, thus looking upon the definition of "ratio" as the multiplicity relationship between comparative amount and that of standard, and using the viewpoint on " A• B=A ÷ B =A/B" to look at the questions of ratio; while what new courses emphasizes is the process that children construct mathematics concepts, therefore new courses think radio is two amounts A and B, causing the match relationship owing to some reason, calling these number A and B have equal relationship., and using "radio" is "A• B" to record the equal relationship between A and B, considering the question of ratio is based on equal relationship and transfer to another equal relationship of the same value, via the simultaneous repetition and the equal cut activity of the two amount of the equal relationship [2]. The previous activity of ratio problems in new courses in 1993 is that of exchange, and the solving tools of ratio problems are the graph of ratio line. Owing to the operation of lineal graph, we can grasp the relationship of radio to further the activity meaning of transference.

2.3 Basis of System Establishment

The system is a learning environment in the internet, adopting three-tier client/server system architecture, namely adding a layer of Service Server to the original structure of two -tier client/server system architecture. In the three -tier client/server system architecture, the management part of learning data is in the charge of Database Server, Web Server assumes the responsibility for teaching; whereas the client user is carried on by all kinds of learning activities through browser.

3 Simulation of Networked Constructive Pedagogy

In order to grasp the "route difference" of the students' mature concept, the system must recognize clearly how the students think about the problems and how they solve the problems so as to adjust the next activity according to the students' thought and to help children clarify the concepts by using the communication of solving the problems and mode of discussion, so the learner' s mathematics knowledge can be upheld accordingly[4,6]. Thus, the system designs operation tool table (as in Figure 1), in which all sorts of tools represent various modes of thought. The students have to utilize these tools to solve the problems; owing to the different tools, the system can grasp the students' process of solving the problems and thought. The flowchart of teaching in this system (as in Figure 2) starts with posing the problems as far as the pedagogic process of any problem, then it is up to the children to decide if they need to be provided clues or graphic emblems to help comprehend the messages of the problems. If necessary, the system has to check out the problems of the same lineal graph as number of ratio problems from database of "ratio lineal graph" and the lineal emblem (as in Figure 3); if the students have comprehended the messages of the problems, enter the students' solving the problems. The students solve the problems with all sorts of tools in tool table; then the system judge the mode of solving by the difference of thought of tools• strategy 1, strategy 2,.:. •Different types of solving enter various tableau, and ask the students explicate the process of solving. The system designs some problems according to the types of solving, helping the students reflect. Through the issue and clarification, the spirit of "mode of communication in the process of solving" would come true. After reflecting the process of solving, the students can choose to study and learn the virtual students' other ways or discuss and communicate with others on the line (as in Figure 4). In case there are students, they can enter discussion room for discussion (as in Figure 5); if there is no student on the line or no one wants to study and learn from the perspectives of others, you can enter the virtual students' various ways and elucidation (as in Figure 6)[5].

4 Architecture and Implementation of System

4.1 Design Environment and Tools

This system uses Windows NT server as server as platform. The developing languages include HTML, JavaScript, Active X, ASP (Active Server Page) and so on. ASP is used as the chief way of control and ASP and ODBC (Open Database Connectivity) are also exercised to go with them. The management of teaching material and the users become simplified. As far as the editing course software, Authorware 5 is mainly utilized as the developing tool.

4.2 System flowchart

• 1• Pedagogic situation of networked construction

The flowchart of pedagogic system on the networked construction is manifested in the Figure 7 and the explanation is as follows. The system, through the previous analysis in advance of the class, judges the students' a priori knowledge, by which the system poses the problems, letting the learner solve the problems by themselves. While the students encounter the bottleneck of solving, he can choose the types of the basic lineal graphs or the lineal graphic emblems, and he may discuss and communicate with the students on the line or with virtual students; if the student solve the problem successfully, demand the process of solving and explain those of solving (reflection), then discuss and communicate with the students on the line or with the virtual students. Afterwards, ask the students to record again and explain the process of solving the problem, exploring if the student can use and repeat the strategy of solving in an even simpler and more abstract method, meaning to judge whether the students can comprehend others' methods of solving to proceed the overall assessment finally. Before putting an end to the system, a test about ratio level of thought development as nonroute subject will be exercised on the students, thereby the director will reach a deeper realization of the students' development.

• 2• Database for "student model"• Student model consists mainly of four databases, recording the students' basic data, analyzing their process of solving the problems, the routes of learning and the constructive concepts so as to comprehend their learning state for the reference of posing the problems, by which to understand the students' bottlenecks in learning in order to help them.

• 3• Database of "posing problems of constructive pedagogy"• It saves the teaching content of constructive pedagogy, which contains various types of pedagogic processes, providing the system with sufficient competence to adjust pedagogy positively.

• 4• Database of "questions for tests"• It stores the questions for pretest and posttest. The pretest is used to comprehend the students' acquired knowledge, whereas the backward test, according to the various aims, can be divided into two kinds--formed test and overall test, adopting the proper mode of test.

4.3 Functions of On-line Communication

• 1• Discussion group• This is an open, instead of being a synchronous, discussing place, letting the learner put up the problems on the cooperative notebook while encountering difficulty; other users can answer these problems.

• 2• Discussion room• It provides a synchronous and open discussing place, in which the learner can put forth the explanation, suggestion and exchanging viewpoints as to the difficulty aroused in learning or as to various strategies for solving the problems.

• 3• On-line call• It belongs to the way of one-to-one real-time communication, providing the user with a brief piece of information immediately, to other users on the line or even the teacher, asking them to undertake discussion in Discussion Room.

4.4 Operation flowchart

When the user enters the system by using browser for the first time, the user has to register in advance (as in Figure 8), by which the system acquires the user' s related basic data, so as to proceed to analyze and check. Then take the pretest about background knowledge of learning point to understand if the software content meets the students' need. The system will set the problems according to all types in the problem database (in order to avoid repetition, each type of problems are given at random), and record the state of the learner' s study, according to which, the system would produce routes of connection automatically; and it changes the original learning routes by means of the artificial intelligence. It undertakes the proper learning route according to the students' learning state. Later on, whenever the user enters by using browser for the first time, he has to key in the user name and password. The system can proceed to check, and after making sure, the system will continue the previous learning in accordance with the learning record left in advance. When the learner surveys each teaching activity, the system can record the learning process serving as the analysis of learning. The learner can utilize the function of check to understand hie own state of learning. After each learning is finished, the system will demand each learner record the process of solving and then pose the problems again to give the learner the test; according to the learner' s answering state, which pedagogic activity will be decided to be carried on actively accordingly.

5 Conclusions

Constructive learning theory will be developed far better if it is carried on network by constructive pedagogy, because networked learning can provide an excellent environment for discussion, upholding the convenience for communication; networked learning can attend to the individual difference, because each student is a leading role. The learner can control the progress of learning by himself, achieving the suitable learning. Networked learning the students' social circles of interaction become larger, not confined to the group of his own class. However, if the real situation by simulation can be added, it is believed that it will draw much attention from students' learning, promoting the learning effect.

References

[1] The seminar ofTaiwan Elementary Teachers .• 1996• •Teacher Handbook of Experimental Textbook in Mathematics of Elementary School, Volume 9.

[2] Chu-Tsun Chen. (1998). "The Equal Relationship and Lineal Graph", Collected Issue of Elementary Education. Taipei• The seminar of Taiwan Elementary Teachers .

[3] Ning, Tzyh-chiang,.(1993)."Spirit and Innovative Trend of New Course in Mathematics for Elementary Education –Seen from Perspective of Constructivism", Scholarly Magazine for Scientific Education, Vol. 1 No. 1, pp. 101-108.

[4] Dalgarno, B.• 1997• • Constructivist Computer Assisted Learning• Theory and Techniques. WWW. 21 Oct. 1997. Available• http://services.canberra.edu.au/~barney/articles/ascilite96/paper.htm

[5] Hiltz, S. R.. "Teaching in a Virtual Classroom. 1995 International Conference on Computer Assisted Instruction ICCAI'95 Hsincku, Taiwan". http://it.njit.edu/njIT/Department/CCC/VC/Papers/Teaching.html (1995).

[6] Squires, D. "Can multimedia support constructivist learning? WWW, 21 Oct. 1997. Available" http://www.spirit.net.au/ACEC96/papers/squir.htm (1997).

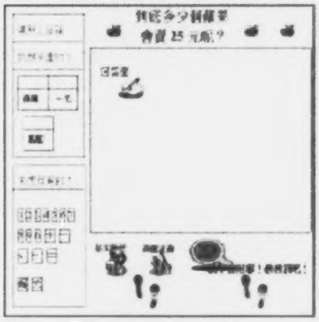


Figure1. Operation tool table.

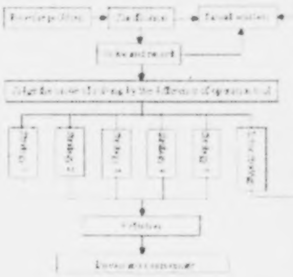


Figure2. The flowchart of teaching in the system.

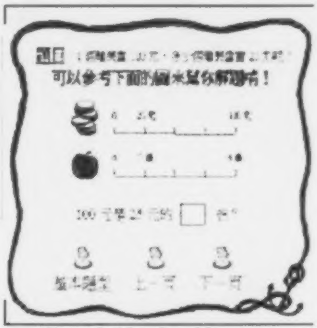


Figure3. Lineal emblem.

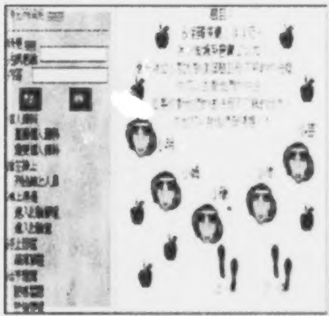


Figure4. To discuss and communicate with the virtual students or on-line students.

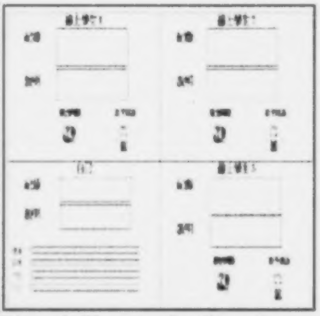


Figure5. The room for discussion.

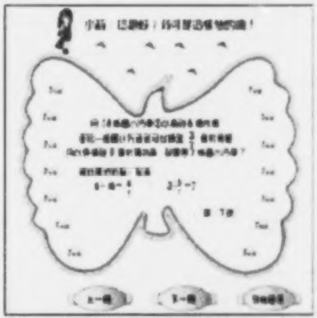


Figure6. The virtual students' various strategies.

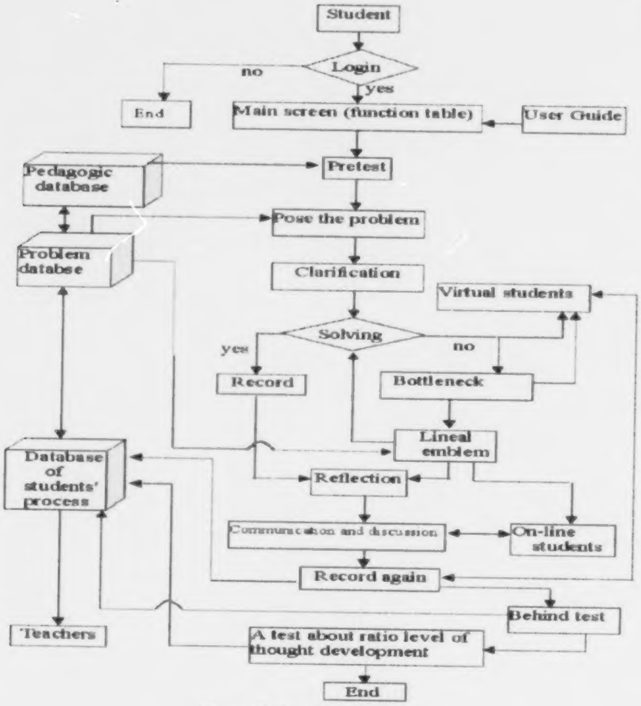

Student
Login
no
yes
End
Main screen (function table)
User Guide
Pedagogic database
Pretest
Pose the problem
Problem databse
Clarification
Virtual students
Solving
yes
no
Record
Bottleneck
Lineal emblem
Database of students' process
Reflection
Communication and discussion
On-line students
Record again
Behind test
Teachers
A test about ratio level of thought development
End

Figure 7. System flowchart.

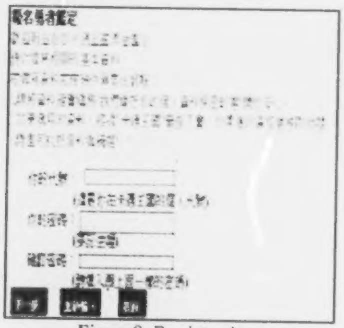


Figure8. Registration.

Online Education: A Learner-Centered Model with Constructivism

Kam Hou VAT
Faculty of Science & Technology
University of Macau, Macau
fstkhv@umac.mo

This paper describes the initiative to construct a WWW-enabled course and project support environment for undergraduate education, aimed to uphold the constructivist's ideas of active learning. The system is intended to create learning experiences that invite students to construct knowledge and to make meaning of their worlds of learning. In particular, we discuss the educational framework of our design through the Problem-Based Learning (PBL) approach, from the perspectives of the architect of the intellect. We also describe the incremental prototyping process of software development, through scenarios of participatory design of our students in Software Engineering at the author's affiliated faculty. The paper concludes by discussing the challenge of implementing the fully functioning constructivist WWW-based environment through blending the art and science of teaching into creative cognitive designs.

Keywords: **Constructivism, Problem-Based Learning (PBL), Learner-Centered Philosophy**

1 Introduction

With the advent of the World Wide Web (WWW or Web) towards the end of the 20th Century, the use of this Internet-based hypermedia technology in education has become the trend of today. The Web is aimed to facilitate learning in different disciplines, and is becoming the major driver to construct numerous experimental Web-based support environment in campuses around the globe. However, online education in the form of Web-based instructions (WBI) or Web-enabled learning environment, without an anchoring philosophy of education, could easily become a technology-rich educational wasteland. The theme of this paper is to investigate how the insights of our educational visionaries [5] could be designed into our Web-based support environment, to suit the unique schemata of individual learners. Actually, such designs require rigor in identifying certain essential elements of the constructivist architecture. And they represent challenges to the learning in our daily classrooms, which has typically involved having students repeat newly presented information on tests or in reports. Constructivist teaching practices help learners internalize, or transform new information, which in turn makes further understanding possible. Therefore, as instructional designers, the guiding question in tackling our Web-based design is this: How do we create a technology-enhanced learning environment that engages students in the types of activities that will take on their initiative and responsibility for their own learning?

2 Project Background

In the spring of 1999, a group of junior students in Software Engineering, initiated an informal study group (ISG) [15] with the author's facilitation. The ISG's mission is to help students develop their team-based technical interest in preparation for their graduation project. And we started exploring the ongoing development of Web-based distributed applications with online education as one of our first discussion topics. During the discussion, the author, as an instructor, expressed his difficulties in traditional classroom setting, to recognize students' intellectual and motivational problems, to explain to them a difficult part of the subject matter, to provide clear tasks, and to coach students in specific problem-solving activities. These issues indeed go far beyond the classroom walls. As students, they expressed their need for a learner-centered atmosphere whose focus is put on the needs, skills, and interests of the learners, and whose goal is to encourage active exploration and construction in the course of learning activity. Likewise, we developed the initial idea of creating an environment where anyone is free to learn, to construct and refine new meaning in one's own learning, and to have enough channels to ask for help, when necessary, in the form of some extended service of a good teacher. We continue our expedition into Web-based technology to turn out the project ideas of creating a) a course support environment for active learning, and b) a project support environment for problem-based learning (PBL). The former has been given the project name **REAL** [13] to imply a Rich Environment for Active Learning, while the latter, **SUPER** [14] to denote SUitable and Practical Educational Resources for group-based project work. And in either project, we have not ruled out the familiar face-to-face classroom interactions between teacher and students, as one of the essential aspects of the learning process.

3 Pedagogical Intakes

In selecting the pedagogy of our Web-based environment, we have borrowed from the legacies of our educational visionaries in blending the art and science of constructivist teaching. John Dewey's designs embedded learning in experience [3]. He advocated field studies and immersion in experiences to stimulate learning. Jean Piaget's work influences constructivist educators through designs of discovery learning [9]. Students manipulate subject matter and objects representing the subject matter as they interpret their findings. He believed that learners' internalization leads to structural changes in how they think about something as they assimilate incoming data. Today, constructing meaning on the basis of one's interpretation of data is the heart of science inquiry, problem-based learning models, and case studies. Lev Vygotsky's theory [16] suggests that we learn first through person-to-person interactions and then individually through an internalization process that leads to deep understanding. This belief in the social process of idea making permeates today's interactive classroom led by skillful teacher questioning. Reuven Feuerstein's mediated learning theory [4] refutes the concept of an unchanging intelligent quotient (IQ) and leads to intense examination of how the classroom affects students' metacognition. He believes that the discovery process requires intervention from the teacher to guide learning. On examining the varied work of the master architects, and trying to crystallize the essential elements of the constructivist architecture, we see an array of tools emerging. They include a learner-centered curriculum; enriched environments; interactive settings; differentiated instruction; inquiry, experimentation, and investigation; mediation and facilitation; and metacognitive reflection.

4 Instructional Design

We expect the instructional design of our Web-based support should increase student participation and communication through re-designing the delivery of college lectures to incorporate more student online activities and instructor's feedback before, during and after the contact session. The environment is expected to develop students' abilities to generate problems, to engage in collaboration, to appreciate multiple perspectives, to evaluate and to actively use knowledge. From the designers' standpoint, we have included the following enabling ideas:

a) *Enable students to determine what they need to learn through questioning and goal setting.* It is believed that students should work to identify their knowledge and skill deficits, and to develop strategies in the form of personal learning goals for meeting those deficits. The emphasis is to foster a sense of students' ownership in the learning process. If teachers, through the Web-based support environment, can guide the students in identifying what they already know and what they need to learn, then knowledge gaps and mistakes can be viewed in a positive way such as another opportunity to learn. And students can assume more responsibility in addressing their own learning needs during any instructional unit.

b) *Enable students to manage their own learning activities.* It is believed that students should be enabled to develop their learning plans, which should describe priorities, instructional tactics, resources, deadlines, roles in collaborative learning situations, and proposed learning outcomes, including presentation and dissemination of new knowledge and skills, if applicable. Traditionally, these instructional events are arranged by teachers to be obeyed by students, in order to accomplish a specified set of pre-determined objectives. Yet, it is not advantageous for students to learn to be self-directed. To manage their own learning activities, students must be guided and supported by the teacher, through the Web-based environment, slowly taking on more and more responsibility of their own learning.

c) *Enable students to contribute to one another's learning through collaborative activities.* It is believed that students should be encouraged and supported to discuss and share their personal findings. Particularly, we should enable students to become co-builders of the course/learning resources through evaluating and refining the entries their peers put into the Web-based depository. Collaborative group-based learning seems appealing to achieve the purpose. Students, nevertheless, must be educated to recognize what they are trying to learn in group-work, value it, and wish to share that value with others. Teachers can provide this sense of accountability and belonging by structuring students' work in the support environment with such concept as computer-supported cooperative work (CSCW).

It is convinced that the efficacy of the learning environment is a function of many complex factors, including curriculum, instructional methodology, student motivation, and students' developmental readiness. Trying to capture this complexity onto the design of our Web-based environment, is more an ongoing iterative process than a one-time activity. So we develop scenarios of situated learning support applicable to both individual course taking and group-based project work. These scenario-based supports are then incorporated into the environment incrementally, subject to our students' participatory testing.

5 Scenario-Based Support

Imagine attending a class where the instructor, after giving an introduction of what the course is entailed, invites you to visit his/her course support environment on the Web. On entering the Web-based environment, you are offered the privilege of creating your own personal space in the form of a customizable Web page guarded by your self-assigned identifier and password. Within your personal Web space, you are furnished with some tools to start your Web-life. These include a communications facility to keep one another in touch (email and newsgroup); a calendar planner to track your appointments or commitments (meetings or homework due dates, or project deadlines); and a frequently-asked-questions (FAQ) tool to send for instructor' s help when encountering difficulty in housekeeping the personal space. Also, there are pathways to other service modules:

a) *Course Information.* This module provides such information as the course description, pre-requisite requirements, evaluation policy, references list, and other details such as time and location of the lectures. It also includes links to the instructor' s contact details, his/her teaching/research profile, and the course schedule showing timetable for class with links to the study materials before, during and after contact sessions. Also included is the announcement service representing the most up-to-date information sent to the students from the instructor.

b) *Course Resources.* This module comprises the study materials prepared by the instructors, and the contributions representing students' submitted or reported work of interest to other students. Study materials can further be cataloged and managed as different resources: study notes, tutorial handouts, supplementary lecture details, or Web-links in the Internet. It could also include FAQs of the course: homework, quiz' s, tests, examinations, and projects.

c) *Course Assessment.* This module keeps track of students' performance. The score each student obtained after completing a specific activity is recorded with enough details for evaluation at the end of the course. Students are encouraged to propose their own study plan to earn the accumulated score required, to complete the course. This service is designed into the Learning Contract [7] component to individualize the learning process for any individual learner. Typically, a student is required to write a formal agreement, which details what will be learned, how the learning will be accomplished, the period of time involved, and the specific evaluation criteria to be used in judging the completion of the learning.

d) *Course Inquiry.* This module fulfills several requirements of the teacher-student inquiry interaction. These include: a) a sense of dedicated space for an extended collaboration between teacher and student; b) an incremental delivery of inquiry results from teacher to student; and c) visibility of the inquiry interactions to avoid duplicating effort, and to encourage discovery of related interests. When an inquiry is initiated by a student, a request Web page is generated which is specific to that interaction and to which the teacher and student return frequently for their interaction. This request Web page (meeting space on the Web), contains the relevant material required for the specific inquiry interaction, say, contact details of the student and the teacher in the form of Web links or email addresses. Each request Web page supports several types of interaction: posting comments, recording actions, uploading/downloading files. These can be carried out at any time in any order. This feature is designed to support the often-time extended discussion and incremental result delivery of the teacher-student collaboration. Also, since the completed request Web page could be visible to any registered student or teaching staff within the Faculty intranet, this increases the general awareness of the teacher's activities in consulting students, and avoids duplicating efforts of other staff in dealing with similar questions from students. More importantly, when users browse the inquiry activities over the Web, they are always exposed to information as to who was involved in what, and eventually they will learn about one another's specialties and interests. Hopefully, they will form communities centered about specific knowledge and interest; such are considered as important assets of any educational institute.

Now, on visiting the Web-based support environment and reading the latest announcement for the next lesson, you are aware that the next lesson is about group-based project work. According to the instructor's message, group project work is an essential component of any academic degree; many professional societies worldwide emphasize project and group work as preparation for professional practice. Also, you are to follow the problem-based learning (PBL) approach to work in teams. And you will be introduced to the teaming process and the PBL support of the Web-based environment.

6 Problem-Based Learning (PBL)

It is understood that project work is recognized as having many educational and social benefits, in particular providing students with opportunities for active learning. However, teaching, directing and managing group project work is not an easy process. This is because projects are often: *expensive* demanding considerable supervision and technical resources; and *complex* combining design, human communication, human-computer interaction, and technology to satisfy objectives ranging from consolidation of technical skills through provoking insight into organizational practice, teamwork and professional issues, to inculcating academic discipline and presentation skills. In preparing our students to get started with group-based project work, we have oriented towards the PBL learning model. According to the literature [1, 2], the modern history of PBL began in the early 1970s at the medical school at McMaster University in Canada, and ever since, PBL has been adopted in various fields such as Teaching, Engineering and Management.

6.1 PBL Pedagogy

The PBL approach focuses education around a set of realistic, intrinsically motivating problems to fit the interests and needs of the learners. It acknowledges the possibility of prior knowledge held by the learner. Further knowledge is acquired on a 'need to know' basis, enabling the learner to diagnose one's own learning needs. Knowledge gained is fed back into the problem in an iterative loop, allowing the synthesis of topics and know-how [10]. When applied to the course setting, PBL should encourage students' active participation, and develop in them self-directed learning and problem-solving skills while they interact, discuss and share relevant knowledge and experience. More importantly, PBL revolves around a focal problem, group work, feedback, class discussion, skill development and final reporting. The instructor's role is to organize and pilot this cycle of activity, guiding, probing and supporting students' initiatives along the way so as to empower them to be responsible in their own learning.

6.2 PBL Activities

Students, on being presented with a problem or scenario, are made aware that initially they will not possess enough prior information to solve the problem at hand or to clarify the scenario immediately. These problems are often ill-structured, but devised according to concrete, open-ended situations. They are reminded that they must identify, locate, and use appropriate resources, and ask questions referred to as "learning issues" on the various aspects of the problem. These learning issues should help them realize what knowledge they require to construct a solution, and thus focus their learning efforts and establish a means for integrating the information they acquire. Often, they are encouraged to perceive themselves as managers of their own in terms of time, material resources, and the complexity of the problems that can be handled one at a time by the group. It is expected that the PBL students have to iterate through some relevant stages of activities: analysis, research, and reporting, with discussion and feedback from peers and the instructor at each stage.

- *Analysis.* Throughout this stage, students organize their ideas and prior knowledge related to the problem, and start defining its requirements. This helps them devise a specific statement of the problem. Meanwhile, they are encouraged to pose learning issues, defining what they know and what they do not know. This helps them assign responsibilities for research, eliciting and activating their existing knowledge as a crucial step in learning new information.

- *Research.* Throughout this stage, students collect necessary information on specific learning issues raised by the group. They may conduct library searches, seek sources on the Internet, collect data, and interview knowledgeable authorities. More importantly, students teach themselves as they research their learning issues. It is intended that when they come to realize the complexity and texture of the problem, they may often see that information is a means to the ends of managing problems effectively.

- *Reporting.* At this stage, students report their findings to the group. Individual students become "experts" and teach one another. Subsequently, their discussion may generate a possible solution, or new learning issues for the group to explore further. Final solutions are constructed, and the facilitator' s feedback should help students clarify basic information, focus their investigations, and refine their problem-solving strategies, besides addressing whether the original learning issues were resolved and whether the students' understanding of the basic principles, information, and relationships is sufficiently deep and accurate.

6.3 PBL Teamwork Experience

It is important that PBL students are taught how to work in teams and positively experience the team process because the team skills they acquire are applicable throughout their future careers. The PBL team process requires each team composed of 3-5 students, to be assigned a supervisor (instructor) and a client if applicable. The client' s role is to clarify the project, and to resolve ambiguities as they arise, whereas the supervisor' s is to guide, motivate and provide feedback to the team. Also, one of the team members is designated the team leader for the duration of the project, whose role is to coordinate the team activities, and to ensure effective team communications. The leader also has to interface with the supervisor, arrange meetings with clients when necessary, and facilitate meeting through setting agendas, taking minutes, and allocating tasks. Each team member has to help set the team goals, accomplish tasks assigned, meet deadlines, attend team meetings and take a turn editing a document to be submitted at the end of each major stage of project development.

Meanwhile, PBL students are made aware of the difficulties in teamwork throughout the project period. These include setting realistic project goals, carefully allocating tasks to team members, managing time, and communicating and managing shared group documents. Teams have regular meetings to which they invite their supervisor, and in which they organize themselves to manage the project. Students are often reminded of setting appropriate agendas before meeting, assigning enough time to the agenda items during meeting, restating the decisions made at the meeting, and converting decisions into action items after meeting. They are also advised on clearly separating the social and work aspects in meetings, and assessing each meeting for doing it better next time. Moreover, it is suggested that teams plan their project around major deadlines of individuals in the team thereby acknowledging the other commitments team members may involve.

Deadlines represent the milestones set down for the PBL students to submit project documents and to receive evaluation. Each team member is assessed by their supervisor and their team peers. The supervisor' s evaluation is based on what each team member adds to the meetings and what the instructor perceives each member' s contributions to the team to be. The peers' evaluation is based on a confidential rating sheet, to be completed by each team member at the end of each major phase of the project. This rating sheet should include each team member' s contribution for that phase with explanatory comments. And the overall project assessment is made up of the group grade and the individual grade. The former is the same for each group member and is based on the quality of the documents produced and the product developed. The individual component is based on the quality of the student' s contribution to the documents and the product, their participation in group-meetings, their commitment to the team process, and their professional attitude developed.

7 Scenario-Based PBL Support

Imagine you have just attended the second lesson on PBL and group project work. And you realize that the PBL support available in the Web comprises both the learning and performance aspects. These are actually a series of strategies and Web-based solutions that use instructional design principles to improve students' work-based performance according to the real-life PBL activities. And you are invited to visit the PBL-specific Web site to register as a PBL-user. The registration process invites you to fill in a Web form including a simple questionnaire for teaming purpose. You are now allowed to enter the PBL-support environment with your PBL identifier and personal password returned after the registration.

And for exploratory purpose, you have just navigated to the PBL Web page for the Software Engineering course *SFTW 300 Software Psychology* (Figure 1). Here you are presented with a number of projects to express your preferences to join through filling in another Web form activated by clicking the link "Join a Team" in the same page. You can then find out which team and project have actually been associated with you by clicking the link "Identify Your Team" also in the same page. On knowing which project to engage, you could click the suitable PBL Space link, i.e., "S300F99P3" in this case, to navigate to the suitable PBL Space (Figure 2). The PBL Space is assigned for each PBL group for project management on the Web. It contains links to the project itself, the PBL Group (including its members' links), the PBL Client, and the PBL Supervisor. Each of such links is associated with a set of related links for information and support of the project. Among the numerous support links in the PBL Group, you can find the *Work Space* link, which leads to the "Group Work Space" (Figure 3) Web page. This page contains links to individual group members and to specific PBL support, as well as to the project interim progress. Clicking on the individual member' s link (PWS) leads to the "Personal Work Space" (Figure 4), where each group member' s progress in terms of PBL activities (analysis, research, reporting, implementation) is tracked.

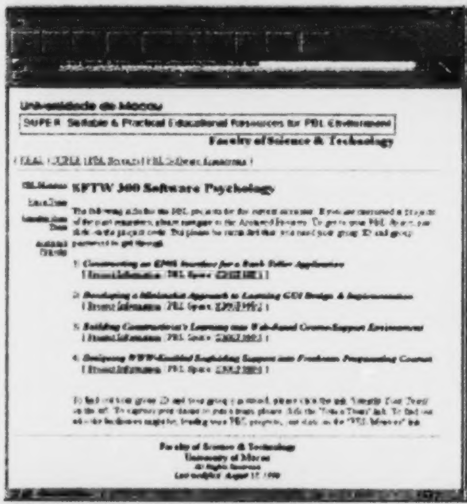

Universidade de Macau
SUPER: Suitable & Practical Educational Resources for PBL Environment
Faculty of Science & Technology
SFTW 300 Software Psychology
Faculty of Science & Technology
University of Macau

Figure 1: PBL Web Page for SFTW 300

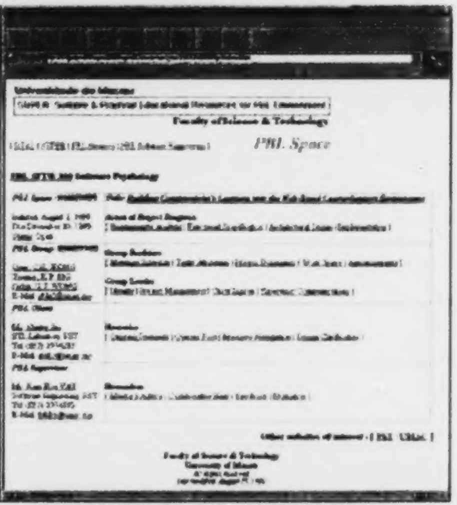
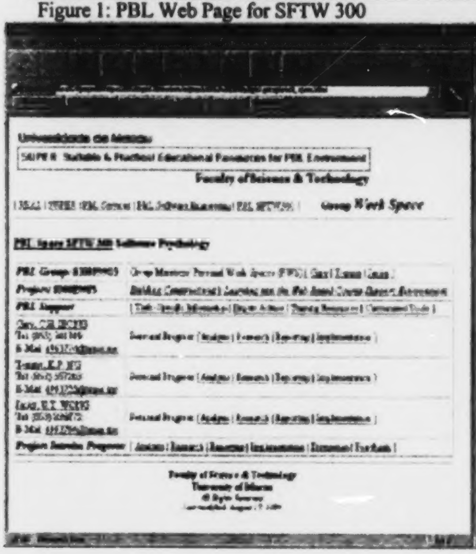

Universidade de Macau
Faculty of Science & Technology
PBL Space

Figure 2: PBL Space for SFTW 300 Project


Universidade de Macau
SUPER: Suitable & Practical Educational Resources for PBL Environment
Faculty of Science & Technology
Group Work Space

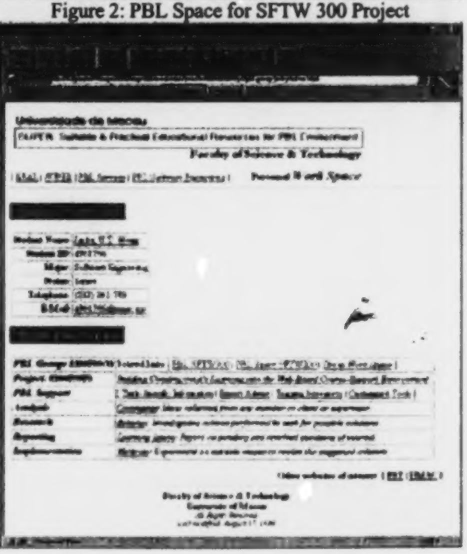

Universidade de Macau
SUPER: Suitable & Practical Educational Resources for PBL Environment
Faculty of Science & Technology
Personal Work Space

Figure 3: Group Work Space for a SFTW 300 Project   Figure 4: Personal Work Space for a SFTW 300 Project

8 Software Development

Our database-driven Web-based support environment has been developed as a series of distributed applications, by employing a mixture of object-orientation, client/server, and Internet (Web browsers, Web servers – HTML, HTTP, FTP) technologies, to deliver the desired support functionality. Such applications are largely event-driven because of the intensive graphical user interface (GUI) programming (e.g., handling the points and clicks) and/or because of the message exchanged between clients and servers over the Web. The specific types of individual Web applications constructed can be categorized into such classes as: a) static HTML-based, b) server-side (CGI-based) and c) client-side (Java-based or JavaScript-based). And the major steps followed to develop the distributed applications could be abstracted as follows:

a) *Analysis.* Establish users' requirements of what information are needed by whom and when, in terms of functionality, performance, security, operability, and management of the distributed applications. And develop an object model that shows conceptually how the information will be organized, accessed, manipulated, and presented in terms of objects.
b) *Architecture.* Partition the architecture concerns into: *data architecture*, determining what data sources (HTML, files, databases) will be needed, where they will be located, and how they will be accessed; *software architecture*, determining what will be written as CGI/Java code, what will be constructed as modules called by CGI/Java, where will the various objects/modules reside, and how they will be invoked (CORBA, RPC); *infrastructure architecture*, determining the servers where the home pages and the objects/modules will reside, the type of gateways that will be employed, the type of middleware that will be needed to invoke remote services and objects (CORBA, ActiveX, RPC, SQL), and the type of computing platforms (PC Windows, UNIX, Linux, Windows NT) used.
c) Implementation and Deployment. Build the HTML pages (including the Java-powered pages) by coding HTML or using filters that generate HTML from other data sources (e.g. Word documents). Then develop and test the software modules and objects. If necessary, purchase the appropriate infrastructure components. Fourth, test, install and deploy the system, followed by maintenance and the iterative re-design process.

9 Prototyping Process

The Web-based support in our online environment is developed incrementally through a user-driven iterative prototyping process, which involves our instructional designers, teachers, and students in the participatory development. This involves creating a series of function prototypes used to clarify the objectives of the system in light of design exploration between the designer and the users (teachers and students), so that the users gradually understand what can be achieved with the technology. Our knowledge of requirements, design and implementation may be incomplete in any one cycle; however, there has been progressive build-up of a structure, which will lead to the desirable system. Specifically, we have referred to the Dynamic Systems Development Method (DSDM) [12] for project guidance, which walks us through four main phases of the DSDM life cycle.

The *feasibility study* phase is to define the high level functional requirements of the environment, which refer to the educational support issues. This phase should produce an outline prototyping plan and establish the main non-functional requirements, such as the hardware and software to develop and deliver the system. The *functional prototype iterations* phase is to clarify the detailed requirements for the system. Its output includes a series of prototypes that demonstrate the main system functionality. These early visual prototypes are mainly used to clarify the system objectives between the designers and users. The *design prototype iterations* phase is to refine the functional prototype into a robust product after a more situated evaluation of system requirements. It involves satisfying all the non-functional requirements; i.e., producing a system that will work effectively on the target hardware in the organizational setting. It is understood that all the possible components of the system do not have to be developed in unison. Some may move on to the design and build phase while others are still at the functional clarification stage. The *implementation* phase involves placing the system in the user environment, carrying out any required training, reviewing the system and assessing further developments. The output should include a delivered system, user manuals/training, and project review document.

10 Conclusion

It is experienced that the conventional approach to education remains the instructivist one, in which knowledge is perceived to flow from experts to novices. This transmissive view of learning is most evident in the emphasis on lectures, in the use of textbooks to prescribe reading, and in the nature of tutorials and assessment methods. It assumes that the process of good teaching is one of simplification of the truth in order to reduce student confusion. Yet, this simplification could deny students the opportunity to apply their learning to dynamic situations. We question the transferability of the instructivist learning and ask how much of that which is assigned to academic learning ever gets applied to actual scenarios, when there is such a rapid surge in knowledge commonly associated with the birth of the "Information Age." This is a transference problem. Actually, the content product of learning is assuming a less important role relative to the process of learning as the life of information content shortens and the need for continual learning increases. In designing the Web-based support of our learner-centered environment, we have tried to reoriented towards a meaningful direction by reducing the obsession with knowledge reproduction. And PBL represents one such relief from the constructivist pedagogy. Greening [6] describes it as a vehicle for encouraging student ownership of the learning environment. There is an emphasis on contextualization of the learning scenario, providing a basis for later transference, and learning is accompanied by reflection as an important meta-cognitive exercise. Also, the implementation of PBL is done via group-based work, reflecting the constructivist focus on the value of negotiated meaning. Besides, itis unconfined by discipline boundaries, encouraging an integrative approach to learning, which is based on requirements of the problem as perceived by the learners themselves.

Undeniably, constructivism is a philosophy of learning that is having a major effect on the way that education is conducted today. In this paper, we have tried to spell out the working characteristics of constructivism [11], which have actively shaped the design of our Web-based support. These include: 1) Meaning is not transmitted. Instead, learning occurs as a process of adjustment of existing concepts. 2) Understanding is based on interaction among a complex weave of factors, such as the learners' goals and existing concepts, the content of the learning experience, the context where the learning occurs. 3) Puzzlement motivates learning. This sense of dissatisfaction emerges from experiences that threaten existing conceptual structures. 4) Social negotiation and viability are the principle forces involved in the evolution of knowledge. They ensure that learning is anchored both by the learning community and by the need to test constructions against reality. The effects of such testing are the adjustments in the structure of concepts held by the learner. So, one thing is evident: constructivist learning experiences can exert high cognitive demands on learners [8], and not all learners could respond well to the challenge. We believe the constructivist ideas assembled here make up what we might call pragmatic constructivism. Namely, constructivism could be viewed as a toolbox for problems of learning. If a particular approach does not solve the problem, try another. In keeping with this flexibility, active, social and creative learning can play out in rather different ways, depending on the circumstances. Although the term constructivism suggests a single philosophy and a unique•potent method, there is not such thing as a one-size-fit-all. Rather, our suggestion is to look at constructivism like a Swiss knife with various blades for various needs. That is also the learner-centered philosophy behind our Web-based support for online education.

References

[1] Albanese, M., and Mitchell, S., " Problem-Based Learning: A Review of Literature on Its Outcomes and Implementation Issues," Academic Medicine, Vol. 68, No. 1, 1993, pp. 52-81.

[2] Barrows, H., " How to Design a Problem-Based Curriculum for the Pre-Clinical Years," New York: Springer, 1985.

[3] Dewey, J., " Experience and Education," New York: Macmillan, 1938.

[4] Feuerstein, R., " Instrumental Enrichment: An Intervention Program for Cognitive Modifiability," Baltimore: University Park Press, 1980.

[5] Fogarty, R., " Architects of the Intellect," Educational Leadership, Vol. 57, No. 3, 1999, pp.76-78.

[6] Greening, T., " Scaffolding for Success in Problem-Based Learning," Medical Education Online, 3(4) 1998, pp.1-15. http://www.utmb.edu/meo/

[7] O'Donnell, J.M., and Caffarella, R.S., "Learning Contracts," In M.W. Galbraith (Ed.), Adult Learning Methods. Malabar, Florida: Krieger Publishing Company, 1990, pp. 133-160.

[8] Perkins, D.N., "What constructivism demands of the learners?" In T.M. Duffy & D.H. Jonassen (Eds.), Constructivism and the Technology of Instruction: A Conversation (pp. 161-165). Hillsdale, NJ:

Erlbaum 1992.

[9] Piaget, J., "Piaget's Theory," In P. Mussen (Ed.), Carmichael's Manual of Child Psychology. New York: Wiley, 1970.

[10] Ryan, G., "Student Perceptions about Self-directed Learning in a Professional Course Implementing Problem-Based Learning," Studies in Higher Education, Vol. 18, 1993, pp. 53-63.

[11] Savery, J.R., and Duffy, T.M., " Problem-Based Learning: An Instructional Model and its Constructivist Framework," Educational Technology, 35(5) 1995, pp. 31-38.

[12] Stapleton, J., "DSDM: Dynamic Systems Development Method – The Method in Practice.," Addison Wesley, 1997.

[13] Vat, K.H., "REAL: Towards a WWW-Enabled Course Support Environment for Active Learning," Faculty Technical Report, FST/SE-1999-01, University of Macau, Macau.

[14] Vat, K.H., "SUPER: Towards a WWW-Enabled PBL Support Environment for Software Engineering Education," Faculty Technical Report, FST/SE-1999-02, University of Macau, Macau.

[15] Vat, K.H., "Training E-Commerce Support Personnel for Enterprises through Action Learning," In Proceedings of the 2000 ACM SIGCPR Conference, Chicago, Illinois, USA, Apr. 6-8, 2000, pp.39-44.

[16] Vygotsky, L.S., "Mind in Society: The Development of Higher Psychological Processes," Cambridge, MA: Harvard University Press, 1978.

Schema Theory-based Instructional Design of Asynchronous Web-based Language Courses

C. Candace Chou
Interdisciplinary PhD Program in Communication and Information Sciences
University of Hawaii
Email: chou@hawaii.edu

Instructional design (ID) provides a framework to facilitate both teaching and learning activities. ID also prescribes desirable learning outcomes. This paper introduces the implementation of an ID template in web-based language courses. The ID template incorporates several cognitive strategies based on schema theory. A schema-theory-based model provides a useful framework for knowledge organization and information processing. In a course that emphasizes reading comprehension, schema theory accounts for how learners construct meaning from texts based on the information they encounter, the prior knowledge they already have, and the way they interact with the new information. The ID template consists of four instructional sequences. The cognitive strategies, ID examples, and purposes for each sequence are illustrated. The sequences include warm-up activities, preparatory activities, core activities, and post activities. Each sequence is interconnected with the others and looped back to the beginning in each lesson unit. The preliminary evaluation results indicate the degree of student satisfaction for the ID template for various external and internal factors.

Keywords: **instructional design, schema theory, cognitive strategies, web-based foreign language instruction**

1 Introduction

Instructional design (ID) plays a critical role in the success of distance education. ID is an interdisciplinary science that provides a theoretical background for the design and implementation of instructional units to achieve desirable learning outcomes. ID principles encompass theories in both learning and instruction. Although the instructional design for web-based instruction does share some common principles with instructional design for traditional classroom teaching, the modes of instruction and learning are quite different from each other. The roles of learners and instructors continue to go through fundamental changes as well. What kind of instructional theories can be best applied to web-based education? There is no one single universal theory for all instructional design as the objectives, learning contexts, subject matters, and expected learning outcomes vary from one field to another. The development of ID also depends on the pedagogical principles that the instructors or instructional designers adapt to. The views on instructional design can be approached from different perspectives such as behavioral (Gropper, 1983); systematic (Gagne, Briggs, & Wager, 1992); structural (Scandura, 1983); motivational (Keller, 1983), transactional (Merrill, 1997); and cognitive (Tennyson, 1990; West et al., 1991). Cognitive schema theory especially receives prominent attention in the field of instructional design and language education for its emphasis on the use of aid for perception, learning, comprehension, and recall (Anderson, 1984; West et al., 1991). This paper focuses on the application of schema theory to the instructional design of language courses delivered through the World Wide Web. The preliminary evaluation results are summarized at the end.

2 Theoretical Framework

Why is ID important in web-based distance education? Reigeluth (1983) argued that ID is a linking science between theory and practice. This linking science was further elaborated by Tennyson and Schott (1997): "As a field of study, it provides a theoretical foundation to principles of instructional design, a research base confirming the theoretical foundations, and a direct involvement in the application of those principles" (p. 1). ID theories prescribe the variables and conditions required for certain learning outcomes. Furthermore, the practice of ID utilizes various methods and technologies to develop learning environments based on these theories (Tennyson & Schott, 1997). Many ID models have been developed and the theoretical bases vary greatly. A typical model includes the following five steps: "(1) setting the *objectives;* (2) *preassessment*, that is, determining whether the target students have the prerequisites to benefit from the instruction; (3) *planning the instruction*; (4) *trial*, that is, presenting the instruction for developmental purposes; and (5) *testing* and *evaluation*" (West et al., 1991). Each step can be further divided into more detailed instructional sequences. The focus of this paper is on planning the instruction based on cognitive learning theories. Schema theory is an especially appropriate cognitive learning theory because of its emphasis on knowledge organization and representation.

There is no one single theory called schema theory. It has evolved and become the basic component of many cognitive learning theories. According to cognitive theorists, schemas or schemata are mental data structures that represent our knowledge about objects, situations, events, self, sequences of actions and natural categories (Anderson, 1985; Rumelhart, 1981). Schemata are also like scripts of plays (Schank & Abelson, 1977). In other words, schemata are chunks of knowledge stored in the human mind by patterns, structures, and scaffolds (West et al., 1991). Based on Rumelhart's definition (1981), schemata serve the function of "scaffolding." Knowledge is perceived, encoded, stored, and retrieved according to the chunk of information stored in the memory. Schemata facilitate information processing. Schema can be "instantiated" by specific examples of concepts or events. For example, one's schema for "teaching" can be instantiated by viewing a scenario on the interaction between a teacher and students. As soon as schemata are instantiated, one can associate or recall more similar scenarios (Bruning et al, 1995). Schema theory is appropriate for language instruction due to its powerful explanation of memory and recall. In the case of reading comprehension, schema theory accounts how learners construct meaning from texts based on the information they encounter, the prior knowledge they already hold, and the way they interact with the new information (Bruning et al, 1995, p. 275). As summarized by Andre (1987), schemata serve the following important function in reading comprehension:

1. Providing the knowledge base for assimilating new text information
2. Guiding the ways readers allocate their attention to different parts of reading passages
3. Allowing readers to make inferences about text materials
4. Facilitating organized searches of memory
5. Enhancing editing and summarizing content
6. Permitting the reconstruction of content (Bruning et al., 1995, p. 275).

Schemata provide the backgrounds for learners to comprehend a text by inference. Schemata also make it possible to summarize a passage by selecting the parts that are important to them. These processes cannot be completed without the knowledge structures that schemata provide. Since one of the elements of schema theory is making predictions based on what learners already know, making the link between the old information and the new information has generated a great deal of research interest. Two areas of research in this direction are advance organizer and schema activation.

Advance organizers employ the structure of some materials that the learners are already familiar with as the framework of the new materials. In other words, advance organizers are designed to offer "ideational scaffolding for the stable incorporation and retention of the more detailed and differentiated material that follows" (Ausubel, 1968, p. 148). Advance organizers are relevant introductory materials that are introduced in advance of the core texts. Recent studies have also shown that providing short and concrete examples for upcoming events are more useful to readers than abstract, general, and vague learner organizers (Corkill et al., 1988).

Schema activation refers to the design of activities for the purposes of activating learner's knowledge in similar fields prior to learning new subject matters (Bruning et al., 1995). They are often in the forms of short questions. In a way, schema activation serves similar purposes of advanced organizers by linking new information with old information that the learners already know. However, schema activation relies more on the learners to generate information from their previous knowledge base. Schema activation works better if the schema activating activities are relevant to the to-be-learned information. A study on the reading comprehension of a group of fifth-graders showed that the group with relevant schema activation remembered the reading texts better than the groups with non-relevant schema activation (Peeck et al., 1982).

There are also many other cognitive strategies that help students with reading comprehension. These strategies are designed to help students in gaining control of their learning process for the purpose of comprehending reading texts. Bruning et al. (1995) summarized the following five strategies for reading comprehension:

1. *Determining importance:* Instructional activities can be designed to help learners locating the main ideas of the text. Without knowing the main ideas, readers would have a hard time understanding the text.
2. *Summarizing information:* Students should not only learn to summarize the main ideas in a passage but also generate a text that represents the original one. Students' reading skills improve when their summarization skills improve.
3. *Drawing inferences:* Studies have shown that the ability to make inferences is positively associate with reading skills (Dewitz et al., 1987; Raphael & McKinney, 1983). Good readers are usually good at guesswork.
4. *Generating questions:* Good readers ask questions frequently. Through self-questioning or peer-exchanged questions, learners will have a better understanding of texts.
5. *Monitoring comprehension:* Readers should have the ability of knowing when they understand the text and when they do not. A good reader also has the ability to detect errors and inconsistencies in the reading materials. When they become critical of the reading texts, they do a better job in detecting errors. Peer editing or peer-critiquing is a good way to monitor comprehension (Bruning et. al., 1995, p. 279-284).

The next section describes how some of the cognitive strategies can be employed in the instructional design of web-based language courses.

3 Instructional Design Template for Web-based Language Courses

The web course introduced in this paper is the first one in a series of Asian language courses using the same instructional design templates. There is a lack of higher-level language courses (3rd year and above) in Less Commonly Taught Languages (LCTLs) such as Asian languages and other non-Roman languages in American universities and colleges. Yet, the need for higher-level language courses does exist for students who would like to continue language studies. The objectives of the web courses are to provide opportunities for students whose institutes do not provide language courses in LCTLs and to disseminate information on the ID model of pedagogically sound language instruction. The first course that is currently offered through the University of Hawaii systems is a Chinese reading and writing course at the 3rd and 4th year level. A Chinese listening/reading/writing course and a Korean reading/writing course will be offered in fall 2000. More courses in Japanese and other LCTLs are in the planning stage at present. The instructional design template is summarized as follow:

Goal: To improve Chinese reading and writing skills.

Objectives:

1. Students will possess the skills to decipher reading materials through a series of cognitive strategies.
2. Students will improve writing skills through continuous revisions, peer-critique, and teacher feedback.
3. Students will have a good command of vocabulary in the subject matters covered in the course.
4. Students will co-construct knowledge together through collaborative tasks in building word bank, grammar clinic, and essay database.

Content: The content covers a wide variety of topics based on authentic teaching materials collected from China and Taiwan, including topics such as cuisine, travel, medicine, celebrities, university, and so on. These materials were developed into ten self-directed reading lessons on a CD-ROM. The web course uses the CD-ROM as the core reading materials. Each web lesson unit was designed to enhance the understanding of the equivalent core text in the CD-ROM.

Format of the Instruction: The World Wide Web and the CD-ROM were selected to deliver the instruction and course content. Asynchronous communication via email and web-forum are the means for student-student and student-teacher interactions.

Table 1 Instruction design template for web-based language courses

ID Sequence & Modules	Cognitive Strategies	ID Examples	Purposes
1. Warm-up activities	Schema activation	Word bank	Brainstorming on terminology Co-construction of knowledge base
2. Preparatory activities	Advance organizer	Picture matching	Preparation for forthcoming texts
3.1 Core activities	Determining importance Drawing inferences	Working on CD-ROM reading activities	Determining the importance of information
3.2 Core activities	Generating questions	Q&A	Self-questioning
3.3 Core activities	Scaffolding	Small Group Discussions	Debate/Discussion/Role Play Use input for other activities
3.4 Core activities	Monitoring comprehension	Grammar Clinic	Peer editing with teacher feedback
4.1 Post activities	Modeling	Sample essay	Teacher demonstration
4.2 Post activities	Recall	Language work	Monitoring comprehension
4.3 Post activities	Summarizing information	Composition & revision	Individual output with collective database on writing samples

Sequence of Instruction: The framework of the instruction sequence is adapted from Hiple and Fleming's (1996) work which is specifically designed for foreign language instruction. The ID examples are developed by the instructors Fleming & Lu (1999) for web-based language courses. There are eight units in each web course. Each unit employs the following four sequences of instruction.

1. *Warm-up activities:* These activities employ simple and short questions to activate learners' previous knowledge relevant to the subject matter. For example, on the unit for cuisine, students are asked to write down two or three things they know about Chinese cooking. Their responses are put into a database called the "word bank." By the end of each unit, students have accumulated an abundant collection of glossary under a specific language topic.
2. *Preparatory activities*: Students are asked to match some descriptions with pictures. These pictures provide a background information of the lesson and prepare the students for the forthcoming texts.
3. *Core Activities*: There are four components in Core Activities: working on the CD-ROM, Q & A forum, Small Group Discussions, and Grammar Clinic. Students first go through the reading activities in the CD-ROM. They then post questions about the content of the CD-ROM on the Q & A web forum. Following that, they are divided into three-member or two-member small groups to carry out a conversational task. Take the cuisine unit for example, they have to make up their minds on which restaurant to go to for dinner. One conversation example is provided so that students know in advance the scope and depth of the expected conversation. In Grammar Clinic, the instructors pick several erroneous sentences from the Small Group Discussions and post them

at the Grammar Clinic (a web forum) for peer editing and critiquing. All these sentences are posted anonymously.

4. *Post Activities*: In the final stage the learners model from teacher's examples and peers' writings before they work on their own essays independently. First, the teacher provides a sample essay and a language matching exercise to reinforce the key words in the essay. Gradually, teachers withdraw help and let the student compose their own essays. If they have a hard time starting, they can view other students' submissions of essays in the database to come up with more ideas.

Among the eight units, the last two units are designed for language exchange with native speakers from the country of the target language. For more details, please refer to the web site (http://www.lll.hawaii.edu/yuedu). The ID template can be modified for different language instruction. The Word Wide Web is an especially perfect media since all information is recorded and saved in the database. Students can always go back to review the collective database for their own review.

4 Evaluation of the web course

In the evaluation process, the instructional design team is interested in student feedback on the sequences of instruction. At the end of each unit, students are asked to fill out an anonymous feedback form that consists of 10 questions on a five-point Likert scale. Comment areas are provided for each question. Table 2 shows the preliminary partial results on the ID template evaluation.

Students had provided valuable feedback to the instructional design team. The team was able to use this feedback to adjust course content and activity design. Generally speaking, students agreed that most instructional design modules are useful for their learning. The degree of helpfulness varies from module to module. However, it seems that the students generally did not like the use of the CD-ROM. One reason is that the CD-ROM could only be used on a Macintosh while 95% of the students in the class used PC-compatible computers. PC users were restricted to use campus Macintosh computers to access the content in the CD-ROM. Furthermore, since the CD-ROM was developed for self-directed learning, there was also a lack of interaction between students and teachers. Finally, there were some bugs in the programming of the CD-ROM. Students were not enthusiastic about the programming bugs. The team is in the process of converting the CD-ROM into cross-platform media and fixing the bugs.

Table 2 Feedback on Instructional Design Lesson Template

1 = Strongly disagree; 2 = Disagree; 3 = Slightly Agree; 4 = Agree; and 5 = Strongly Agree		Unit 2 (mean)	Unit 4 (mean)	Unit5 (mean)	Unit7 (mean)
	Post Unit feedback questions	(n=11)	(n=9)	(n=11)	(n=9)
Q1	I have gained new knowledge from this unit.	4.09	3.78	3.73	3.56
Q2	When I ask for help, the instructors respond in a timely way.	4.45	4.33	4.09	3.33
Q3	When I ask questions, the instructors give me the answers I need.	4.36	4.33	4.09	3.67
Q4	The warm-up activities are useful. (i.e. contributing and sharing vocabulary)	3.73	3.78	3.73	3.44
Q5	The preparatory activities are useful. (i.e. matching pictures to text)	3.91	3.67	3.36	3.22
Q6	The content of the core lessons (CD-ROM) is well designed.	3.18	3.33	2.91	NA*
Q7	The forum discussions (i.e. Q&A, role-play, small group discussion) are useful.	4.09	3.78	3.73	3.33
Q8	The grammar clinic is helpful	3.45	3.89	3.73	NA*
Q9	The language work is at the proper level of difficulty.	4	4.00	3.55	3.56
Q10	The essay writing is at the proper level of difficulty.	4.09	4.22	4.09	3.67
	Average	3.94	3.91	3.701	3.473

* Unit 7 is designed for language exchange. The questions on CD-ROM and Grammar Clinic are not applicable.

As for the web-based instructional modules, the warm-up activities were not deemed as useful as the instructional design team had expected them to be. When monitoring student online activities through the server-tracking program, it was found that most of them did not go back to use the database after submitting the required entries. The instructor started requiring the students to incorporate the vocabulary into their essays towards the end of the semester. By then, it may have been too late to see how the change in instructional strategy would affect the way the students utilize the database. This is a good lesson for instructional designers. All instructional sequence should be interconnected and continuously looped back to the beginning. If the instructional modules are designed as stand-along units, students will not see the purpose of building on the knowledge based that they have co-constructed.

Finally, there seems to be a slight decline in the helpfulness of the ID modules when comparing the average in table 2. The perceived helpfulness declines especially in unit 7. The change in instructional format (i.e., language exchange) and the more specialized topic (i.e., movies) may have posed a greater challenge for less competent students. Interviews with the student may help to find out the real reasons. Nevertheless, the comments from students were overall positive. Here are a few comments from the students.

> " The warm-up activities have been very helpful in preparing for the entire lesson."
>
> "The preparatory activities makes one think harder about the subject material."
>
> "Small group discussion wasn't as interesting as the previous units because there were a little interactions among students."
>
> " I believe I would not have learned all of the new words from a textbook. Contributing and sharing vocabulary for this unit has really helped my ability to read the Chinese newspaper's entertainment section."
>
> "The text for this section was presented in a way that forced me to focus and analyze more fully the meaning. A good challenge which I enjoyed."
>
> " This unit helped me to learn unique vocabulary for discussions with almost any Chinese speaker. I am more confident that I can carry a conversation with a Chinese speaker about my favorite movie."
>
> "While on occasion some vocabulary has been a little bit difficult, once I put the sentence or paragraph into context, the usage of the vocabulary became more clear."

5 Conclusions

ID sets up a framework for desirable learning outcomes. The incorporation of cognitive strategies helps students to efficiently achieve the learning objectives. It can be found from their comments that the students valued greatly the aspects of online interaction and co-construction of a knowledge database. It is through the collaborative tasks that they are able to interact for a purpose, i.e., for the completion of a task that has a real-world application. The overall ID objectives have been met through the instructional sequences. Nevertheless, there is not much evidence supporting the effectiveness of the ID modules other than students' own remarks. Further study on the comparison of the actual online activities (e.g. tracking the mouse clicks) with their perceptions on the usefulness of each ID module can provide more insight into the effectiveness of the instructional design. In addition, an objective panel of language experts to evaluate the performance of the students could also provide assessment to the final learning outcomes.

References

[1] Anderson, R. C. (1984). Role of reader's schema in comprehension, learning, and memory. In R. C.
[2] Anderson, J. Osborn, & R. J. Tierney (Eds.), *Learning to read in American schools: Basal readers and content texts*. Hillsdale, NJ: Lawrence Erlbaum Associates.
[3] Anderson, R. C. (1985). *Cognitive psychology and its implications*. New York, NY: Freeman.
[4] Andre, T. (1987). Questions and learning from reading. *Questioning Exchange, 1*, 47-86.

[5] Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York, NY: Holt, Rinehart and Winston.

[6] Bourdeau, J., & Bates, A. (1997). Instructional design for distance learning. In S. Dijkstra, N. Seel, F. Schott, & R. Tennyson (Eds.), *Instructional design international perspective: Solving instructional design problems* (Vol. 2, pp. 369-397). Mahwah, NJ: Lawrence Erlbaum Associates.

[7] Bruning, R. H., Schraw, G. J., & Ronning, R. R. (1995). *Cognitive psychology and instruction*. (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

[8] Corkill, A. J., Bruning, R. H., & Glover, J. A. (1988). Advance organizers: Concrete vs. abstract. *Journal of Educational Research, 82*, 76-81.

[9] Dewitz, R., Carr, E. M., & Patberg, J. P. (1987). Effects of inference training on comprehension and comprehension monitoring. *Reading Research Quarterly, 22*, 99-119.

[10] Fleming, S., & Lu, J.-Y. (1999). *CHN399a: Chinese Reading and Writing Course*. Available: http://www.lll.hawaii.edu/yuedu.

[11] Gagne, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design*. (4th ed.). Fort Worth: TX: Harcourt Brace.

[12] Gropper, G. L. (1983). A behavioral approach to instructional prescription. In C. M. Reigeluth (Ed.), *Instructional-design theories and models* (pp. 101-161). Hillsdale, NJ: Lawrence Erlbaum Associates.

[13] Hiple, D., & Fleming, S. (1996). *Stages of a receptive skill lesson development*. Available: http://www.lll.hawaii.edu/workshops/chinesenet/lessons/stages.html.

[14] Keller, J. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 383-437). Hillsdale, NJ: Lawrence Erlbaum Associates.

[15] Merrill, M. D. (1997). Instructional transaction theory: An instructional design model based on knowledge objects. In R. D. Tennyson, F. Schott, N. Seel, & S. Dijkstra (Eds.), *Instructional design international perspective: Theory, Research, and Models* (Vol. 1). Mahwah, NJ: Lawrence Erlbaum Associates.

[16] Peeck, J., Bosch, V. D., & Kruepeling, W. (1982). The effect of mobilizing prior knowledge on learning from text. *Journal of Educational Psychology, 74*, 771-777.

[17] Raphael, T. E., & McKinney, J. (1983). An examination of fifth- and eighth-grade children's question answering behavior: An instruction study in metacognition. *Journal of Reading Behavior, 15*, 67-86.

[18] Reigeluth, C. M. (1983). *Instructional-design theories and models: An overview of their current status*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[19] Rumelhart, D. E. (1981). Schemata: The building blocks of cognition. In J. T. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 3-26). Newark, DE: International Reading Association.

[20] Scandura, J. M. (1983). Instructional strategies based on the structural learning theory. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 383-437). Hillsdale, NJ: Lawrence Erlbaum Associates.

[21] Schank, R. C., & Abelson, R. (1977). *Scripts, plans, goals, and understanding*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[22] Tennyson, R. D. (1990). Integrated instructional design theory: Advancements from cognitive science and instructional technology. *Educational Technology, 30*(8), 14-21.

[23] West, C., Farmer, j., & Wolff, P. (1991). *Instructional design: Implications from cognitive science*. Englewood Cliffs, NJ: Prentice Hall.

SimPCS: A Web-based PCS Learning Tool

Chyi-Ren Dow, Yu- Feng Hwang, and Jong-Shin Chen
Department of Information Engineering
Feng Chia University, Taichung, Taiwan 407
{crdow, baterma, and jschen}@pluto.iecs.fcu.edu.tw

With rapidly growing interest in the area of wireless communications in recent years, the wireless resource allocation problem has received tremendous attention. The demand has led to intensive research and studying efforts for personal communication systems (PCS). Many related courses have been offered and corresponding web-sites were developed. Unfortunately, most of the web-sites contained only static and pre-defined PCS information. The utilization of wireless resources is determined by many complex factors such as geography, the distribution of mobile subscribers, and the communication congestion. It is difficult to understand the characteristics of PCS by using only the conventional education materials. This work designs, develops, and implements a web-based PCS learning tool that meets the above criteria. The system provides the merits of personality, transparency, efficiency, scalability, portability, and flexibility. It offers simulation and data analysis so that the user can learn actively and understand easily the advanced issues of PCS.

Keywords: **Web-based learning, PCS, simulation, performance visualization**

1 Introduction

Computer-assisted instruction (CAI) programs based on Internet techniques, especially on the WWW, provide new opportunities in various applications. Due to the reason that the growing popularity of the World Wide Web, the characteristic of its portability, wide acceptance, and comprehensive availability can help us to solve many problems related to conventional CAI systems, which lack portability and local availability.

A PCS system is a wireless network that provides communication service with mobility to its subscribers. With rapidly growing interest in the area of wireless communications in recent years, many related courses (e.g., wireless communications, mobile computing, personal communication systems, etc.) have been offered and corresponding web-sites were developed. However, most of the web-sites contain only static and pre-defined information of PCS. Few web-based PCS learning tools have been developed to provide a highly interactive facility for users.

The wireless resource allocation problem has received tremendous attention in the last few years and the demand has led to intensive research and studying efforts for the related topics. Unfortunately, the utilization of wireless resources is determined by many complex factors such as geography, the distribution of mobile subscribers, and the communication congestion. It is difficult to understand the characteristics of PCS systems by using only the conventional education materials. Simulators can be used to identify various characteristics of PCS systems and to support decisions and understanding by giving the possibility of experimenting with different scenarios [24].

However, the simulation of a PCS scenario is time consuming for large-scale PCS systems. Therefore, scalability is an essential factor for the simulation of PCS systems. As well known, conventional sequential simulation techniques can not adequately fulfill such simulation requirements, necessitating the development of parallel simulation techniques capable of doing so. On the other hand, when very great amount of users use the simulation system at the same time, the load of the server will be quite heavy so that the performance decreases rapidly and the response time of a simulation experiment increases.

It is essential that a learning system should be capable of providing the flexibility of usage profiles and services for different users. Users can be classified according to the conditions of user's ability, frequency, and so on. It is expected that each user may have an adaptive interface and configuration to fit his/her requirement. Furthermore, in order to improve the performance of a simulation system, the technologies of parallel processing and caching should be applied. The user may reuse previous simulated results without doing a long-running simulation experiment again, thereby reducing the waste of computation resources of application servers. It not only reduces the waste of the computation resource but also provides real-time services for users.

In light of above discussions, we develop SimPCS, a web-based learning tool for PCS which integrates simulation and computing in a multimedia learner environment with various enhanced functionalities. The proposed system has the merits of personality, transparency, efficiency, scalability, portability, and flexibility. The system can be used to help users to understand the concepts of PCS systems. By using the PCS simulation and data analysis, the users can understand the advanced issues of PCS environments (e.g. resource allocation, probability of blocking call, etc.).

The rest of this paper is organized as follows. Section 2 discusses the architecture of conventional CAI systems and related technologies applied to our system. Section 3 describes the proposed system architecture. The implementation of our system and a prototype are illustrated in Section 4. Section 5 discusses the usage profiles and case studies. Finally, conclusions are offered in Section 6.

2 Related Work

In recent years, training environments based on computational simulation are being used much more frequently and the importance of simulators is widely appreciated. They are used to support decisions and understanding by giving the possibility of experimenting with different scenarios. For a training environment, one thing that is commonly assumed is that the trainee has a reasonable amount of knowledge about the subjacent model and is capable of analyzing and learning from the simulation results [4]. Form a user's aspect, the tools must have characteristics of convenience, auto-analytic, assistant, resource sharing and so on [10,18,20]. The rationale behind the use of multimedia in education is that some media transmit certain kinds of information better than others. This makes it possible to give media an extremely important role in the context of education and learning [6]. The motivation for the use of simulation in an education is that it supports an active learning approach and maximizes the learner control [18]. The degree of available learner control defines the perceived level of interactivity of a course [19]. Learner control is seen as the control over learning strategy, manipulation of learning content and description of content [14]. The claims are that an active learning approach facilitates learning. Learners appear to be more engaged and have better motivations. Simulation enables learners to make their own errors, try to find these out, explore these and learn from these. Moreover, simulators are powerful in situations in which they otherwise would be difficult or impossible to give training or education. It is realized that simulation needs to be embedded in an instructional environment to fulfill an instructive role in a satisfactory manner [23].

In this way the content of a conventional CAI program, which is necessarily limited, can be strongly expanded. Web-based CAI programs differ from conventional CAI software [8,12-13,17,21] significantly and therefore require a specific consideration. It can be utilized on almost all of computer platforms. The materials of CAI systems can be shared since WWW is based on the network technologies. The learners can be free from restrictions of space or time. Conventional CAI programs can be stored on data media, installed, and used on stand-alone computers [1]. By contrast, WBT (web-based training) programs are based on Internet technology, in particular on WWW technologies. Generally, CAI programs can be subdivided into three layers: presentation, teaching, and domain data and knowledge. These combinations generate different types of architectures [6].

Many efforts have been made to improve the limitations of wireless communications [9,11]. In order to increase the system capacity, many advanced channel allocation schemes were proposed [13,21]. Another way to increase the system capacity is to split the cell into micro-cells. The micro-cell architecture is an efficient way to increase the total available channels but additional infrastructures are needed [21]. Many simulation languages and tools have been developed for the simulation of large-scale networks such as cellular mobile systems. Parsec, a parallel simulation language, can be used to develop simulations for complex systems and mobile wireless networks [16,22]. Other systems were developed that can simulate large-scale cellular mobile systems [2]. They used discrete event scheme to model cellular mobile systems and proposed the synchronization schemes to avoid faults distributed computing environments. Lin [15] proposed a PCS handoff simulator that supports arbitrary PCS cell structure and can be used to evaluate the call blocking probability or forced termination probability.

3 System Architecture

In this section, we describe an overview of our system architecture and the functionality of each component. Figure 1 illustrates the system architecture layout from three different viewpoints, the interaction type, distributed teaching program, and system configuration. For the interaction type, the system provides methods of presentation, browsing, and simulation. The user can interact with the system through various interaction types. For the distributed teaching program, it describes the architecture of client-server and layers for distributed teaching. For the system configuration, it describes the detailed modules of the system.

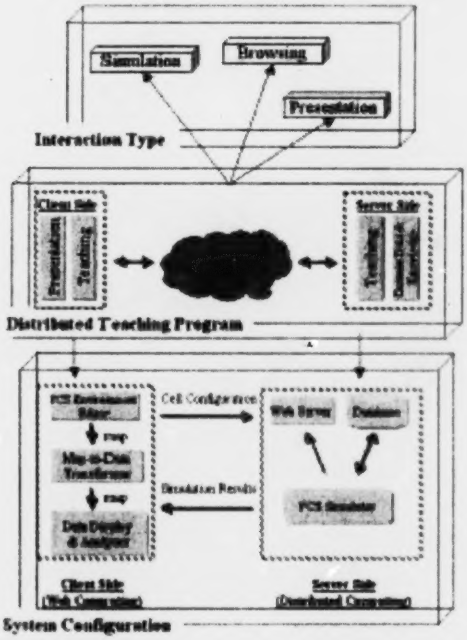

Simulation
Browsing
Presentation
Interaction Type
Client Side
Presentation
Teaching
Server Side
Teaching
Distributed Teaching Program
PCS Environment Editor
map
Map-to-Data Transformer
map
Data Display & Analyzer
Cell Configuration
Simulation Results
Web Server
Database
PCS Simulator
Client Side
(Web Computing)
Server Side
(Distributed Computing)
System Configuration

Fig. 1 System architecture

3.1 Interaction Type

SimPCS provides three interaction types including browsing, simulation, and presentation. The details of each interaction type are described as follows.

(1) Browsing:

Here, the user can determine the contents and the consequences of the presentation by accessing the contents through freely navigable hypertext. Internet users can browse the system through a Java-enabled GUI (graphical user interface). In order to reduce the response time of simulation, the caching mechanism is applied, which allows the user to quickly obtain the simulation results and without wasting the computational resources of the application server. Moreover, it provides basic functions to support analysis and display of performance information. The user can determine the contents and the consequences of the presentation by accessing the contents through borrowing.

(2) Simulation:

In the simulation system, the user can easily construct a PCS environment. Then, the user can assign the parameters related to the PCS environment. Next, the parameters are embedded to our parallelized simulation system. Finally, users can use visualization functions to analyze the characteristics and observe the performance variation of different factors. In addition, the system provides various virtual objects to let the user simulate a real environment. On the other hand, the techniques of parallel processing and caching are applied to the system to improve the efficiency of the system.

(3) Presentation:

In this case, the system presents the information in a linear manner just like slide show. The system provides static education materials such as slides, notes, simulation results, and other related information. The system can also be used to support distance learning of PCS environments.

3.2 Distributed Teaching Program

The distributed teaching architecture offers the best performance and the least network traffic of all web-based training architectures. The system we provide belongs to this architecture. On the client side, the presentation layer constitutes the interface between the user and the teaching layer. It is responsible for the presentation and management of usage profiles. It provides the flexibility of usage profiles and services for different level of users. The teaching layer handles user activities (mouse actions, inputs and so on), and then responses to the presentation layer. It is implemented in our system with JAVA programming language to process user activities. On the server side, the teaching layer is responsible for the simulation of PCS systems and processes queries. In order to improve the performance of simulation, the techniques of parallel processing and caching are applied. In the domain data and knowledge layer, the simulation data is saved in a database. It has considerable advantages: multi-stage queries to the data and knowledge layer can be completely created and executed on the server.

3.3 System Configuration

The system configuration consists of many modules. On the client side, the user can use any Java enabled browser. Internet users can communicate with the system through the GUI. The server side provides the ability of the simulation. The PCS environment construction system is used to minic a PCS environment. After constructing an environment, a map representing the environment is transferred to cell configurations. The cell configurations are sent to the PCS simulator and the map is sent to the performance data analyzer. The PCS simulator is used to simulate the behaviors of mobile hosts on the constructed PCS environment. After the simulation, the results are sent to the performance data analyzer/display. Then, the system analyzes the performance data and visually displays it on the map. The database server stores cell information and simulation results obtained from the application server.

The client side is java-based interface. It can enable the users access the system through a WWW browser. The client side consists of a PCS environment constructor and a performance data analyzer. The PCS environment constructor consists of a PCS environment editing module and a map-to-data transformer module. Their features are listed as follows:

(1) **PCS Environment Editor:** the PCS environment construction system is an iconic editor. It provides many iconic objects to represent different things such as a station, highway, or city. With these objects, the user can set up different parameters to change the cell configuration. For instance, the user can set up a station or a city in a cell and the system will automatically change the parameters of the cell such as the number of MHs and call arrival rate. This mechanism makes the simulator more practical.

(2) **Map-to-Data Transformer:** the transformer is used to transfer the map (constructed by PCS environment construction system) to readable parameters for the simulator.

On the server side, the simulation system consists of three components: a Web server, a database server and an application server. The Web server is in charge of communication with the client and manages the application server. The database server stores cell information and simulation results obtained from the application server. Because the database server provides a caching mechanism, the user may replay the

BEST COPY AVAILABLE

simulation results without wasting the execution resource of the application server. Therefore, simulation is more efficient. The application server is responsible for the execution of the PCS simulator. The application server can be a distributed computing environment (i.e. a network of workstations or a supercomputer). The PCS simulator on the application server can simulate large cellular mobile systems more efficiently with these powerful platforms.

The PCS simulator is used to simulate the behaviors of MHs on a specific PCS environment. The basic behavior of a base station (BS) is to provide channel allocation service and communication service for mobile hosts (MHs) within its service range (cell). The BS chooses a channel to serve when a MH needs a communication. If no channel is available, either a channel is borrowed from neighboring cells or call blocking occurs. For details, we refer readers to [5].

The client side and the server side can be used independently or together. This will facilitate other PCS simulators to embed to our system. Users can use the PCS environment constructor to construct a simulation environment. Then, they can use performance analysis/visualization tools to analyze results.

4 Implementation and Prototype

In this section, the classification of the system modules is discussed. SimPCS can be used to help instructors to create motivating lectures and allow the students to do experiments so they can understand relative wireless information in depth. Users may compose and simulate a PCS environment using various modules. Figure 2 illustrates the hierarchical relation of these modules.

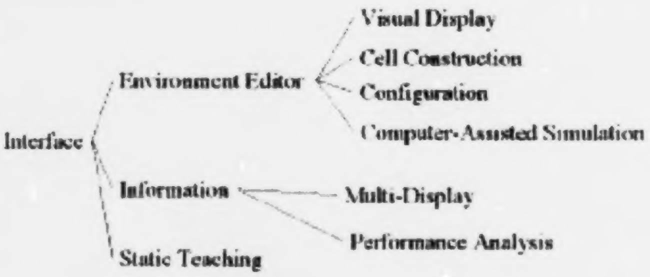


Fig. 2 The hierarchy of modules

(1) Interface module, is the front-end object for SimPCS. It offers the basic functionality required for an interactive program. Its main types of the widgets used to make a control are the pull-down menus and panels, which have the basic file operations and customization at this level. Figure 3 is a snapshot of our system. This layer is the root of all modules of our system. It consists of the environment editor, the information modules, and the static teaching module.

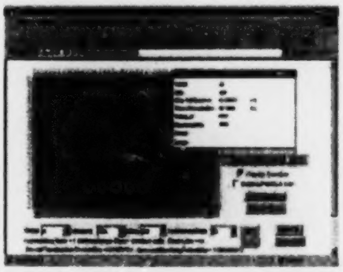


Fig. 3 A snapshot of the system

(2) **Environment editor module**: provides the establishment of a virtual environment. It enables the user to compose and establish complex conditions with virtual objects (e.g., house, river and road), to import and edit a map and save an established map.

(3) **Visual display module**: is an advanced feature of the system. It provides many iconic objects such as a station, highway, or city. With these objects, users can construct a mimic PCS environment. It enables users to simulate a PCS environment. Within the environment, the user can set up different parameters to change the cell configuration.

(4) **Cell construction module**: is responsible for establishing the cells in a selected area of the map. The user can directly select the cells on the map with the mouse. The module can create cells after constructing the environment. Figure 4 shows an example of cell distribution. The module also provides a mechanism of recombination. It uses the performance visualization grains to advance the visualization capability [4]. The technique facilitates to reorganize the performance visualization grains and support various presentations. The system can merge/split the performance visualization grains for specific geographical areas or cells.

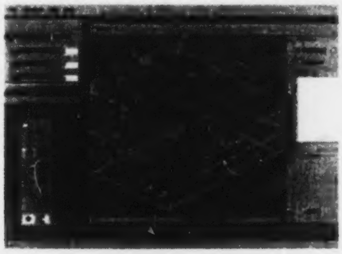


Fig. 4 Cell establishment

(5) **Configuration module**: offers the function of configuration of the objects. It allows users to set and configure the properties and limitations of the objects. The user can set call holding time and residence time of each mobile host. Figure 5 shows the dialog of configuration.

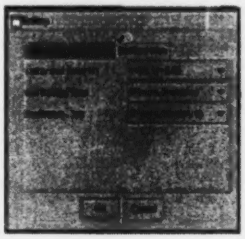


Fig. 5 Configuration

(6) **Computer-assisted simulation module**: as suggested by the name, provides the simulation of practiced conditions. It provides the user with methods to generate parameters of practiced conditions and transmit the queries and parameters form the user interface on front-end to the simulator which applies parallel/distributed computing techniques on the server. It also allows the user to choose several processors in order to run the programs simultaneously. The users can explore their behaviors after simulation.

(7) **Information module:** offers the information of simulation results, which consists of multi-display module and analysis module.

(8) **Multi-display module**: offers advanced presentation forms. It not only displays the static information (e.g. cells, channel, blocked call and so on) but also provides different presentation forms according to different configurations. Currently, two presentation modes are available to the users, color and numeric. In the color-oriented mode, the simulation results can be expressed by different colors. For instance, high blocking probability can be expressed by red color and low blocking probability can be expressed by green color. With this mode, the user can easily identify the area with high blocking probability. On the other hand, the numeric-oriented mode offers users the capability to see the details of each cell.

(9) **Performance analysis module:** provides the basic functions of performance analysis. SimPCS provides statistical analysis functions for the performance data. The main objective is to allow support the users in their efforts to understand the results and behaviors of simulation. The users can analyze the different results and behaviors of simulation according to different factors (e.g. new call blocking, forced termination). Figure 6 illustrates the different types of analysis of simulation results with histograms and pizza graphs.

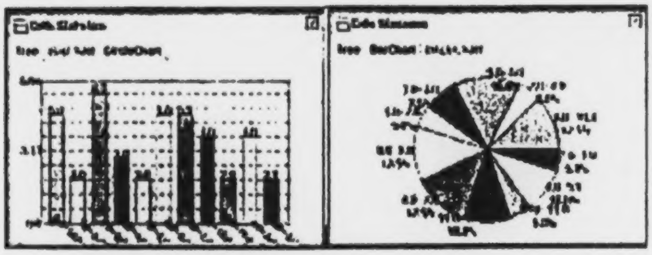


Fig. 6 Different types of analysis

(10) **Static teaching module:** is used to present static education materials. The information of PCS is presented in some manners just like slide show, notes, and simulation results.

After this brief description above, we can refer to the fact that actual prototype of SimPCS has been implemented with Java programming language in an object-oriented development environment.

5 Usage Profiles and Case Studies

This section gives different scenarios of using SimPCS for different users and discusses the services for them. Figure 3 depicts a snapshot of SimPCS for novice users. First, a novice user can select different parameter values such as number of rings(cells), number of channels in a BS, number of MHs in a cell, and the average call arrival rate of MHs. After the novice user selects the parameters, SimPCS accesses the pre-simulated (caching technique) data from the database system and presents the probabilities of new call blocking and forced termination, using the predefined PCS system model. The user can then use the visualization function to refine the presentation of the performance data. Figure 3 illustrates the snapshot of the system with statistical analysis.

The simulation system provides flexibility that means the simulator should provide different services for different users. The proposed performance visualization system classified target users into three groups: novice or first-time users, knowledgeable users, and expert frequent users. Each group will have a different usage jurisdiction. Figure 7 illustrates the relationship between users and operations.

(1) **Novice or First-Time Users** – True novice or first-time users know little of PCS systems nor do they want to understand the concept of PCS systems. These users will use a menu to select items to play with (i.e. ring of cells, number of channel, number of MHs in a cell, and call arrival rate). By choosing different the menu item and seeing the quick feedback on the screen, they will be exposed to an overview of PCS systems. The results have been stored in the caching mechanism on the database server, thereby, reducing system response time.

(2) **Knowledgeable Users** – Knowledgeable users understand concepts within PCS systems such as new call blocking, forced termination, call arrival rate, and so on. The proposed system allows knowledgeable users to execute the PCS simulation with their own parameters. These users tune the allocation of the resource by changing predefined parameters and observe the performance difference between their options.

(3) **Expert Frequent Users** – Expert "power" users are experts with the PCS systems and will develop and implement a PCS system to verify their research. The expert users will construct a PCS environment to mimic the real environment for evaluating performance. Since our prototype provide the capability to construct and mimic PCS environments, users can embed their simulation protocols into our system and use the analysis/ visualization tools tc analyze the performance data.

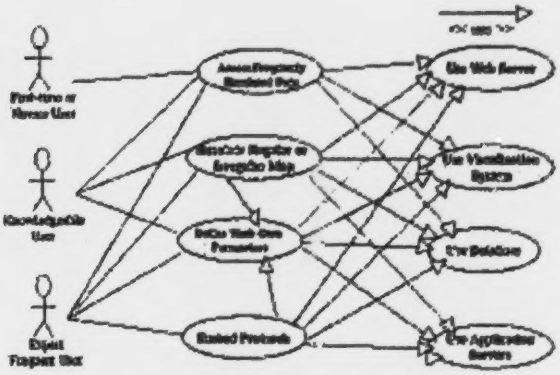


Fig. 7 Available functions for users

6 Conclusions

This work designs, develops, and implements SimPCS, a web-based PCS training and learning tool, to provide users a more flexible learning environment and give users full user-control capabilities. SimPCS can be easily used through a web browser to achieve the goal of cooperative testing and learning. It can simulate large-scale PCS systems up to thousands of cells. SimPCS has the merits of personality, transparency, efficiency, scalability, portability, and flexibility. SimPCS provides many user-directed features. It not only simplifies the complexity of programs but also supplies convenience for the users. Furthermore, the system provides the user with several editing components of the visualization system and many iconic objects to design the simulated environment by clicking the mouse directly. Although related investigations extensively perform simulation studies, relatively few web-based, large-scale PCS learning tools are developed as these models are rather time consuming. SimPCS uses the distributed teaching architecture, which offers the best performance and the least network traffic of all architectures. In addition, parallel processing and caching mechanisms are applied to improve simulation efficiency on server-side and offer a real or accelerated-time simulation.

Acknowledgment

The authors would like to thank the National Science Council of the Republic of China for financially supporting this research under Contract No. NSC 89-2213-E-035-010.

Reference

[1] A. Bittorf, J. Bauer, M. Simon, and T. L. Diepgen, "Web-based training modules in dermatology," MD Computing 14 (5), pp. 371– 376, (1997).

[2] C. D. Carothers, R. M. Fujimoto, and Y. B. Lin, "Simulating population dependent PCS network models using time warp," in Proceedings of the IEEE 45th Vehicular Technology Conference, July, (1995).

[3] M.A. de Juan, M.A. Leon, B. Martin-Calero, A. Mendoza, A. de los Ojos, J.R. Peran, and L.J. de Miguel, "Decision making based on a discrete event simulation tool," in Proceedings of 7th IEEE International Conference on Emerging Technologies and Factory Automation, pp. 335 –341, (1999).

[4] C. R. Dow, J. S. Chen, Y. F. Huang, "Visualization of performance data on PCS systems," International Symposium on Multimedia Information Processing, Taipei, Taiwan, December 14-16, pp. 28-33, (1999).

[5] C. R. Dow and S. H. Hung, "A web-based parallel simulator for cellular mobile systems," ISCA 12th International Conference on Parallel and Distributed Computing Systems Conference, Fort Landerdale, Florida, USA, August, pp. 18-20, (1999).

[6] P. M. Greenfield, Electronic technologies education, and cognitive development. In D.E. Berger, P. Pezdek and W.P. Banks(eds.), "Applications of cognitive psychology: problem solving, education, and

computing.," Lawrence Erlbaum, Hillsdate, NJ, (1987).

[7] M. Haag, L. Maylein., F.J. Leven, B. Tönshoff, and R. Haux, "Web-based training: a new paradigm in computer-assisted instruction in medicine," International journal of medical informatics, Volume: 53, Issue: 1, January, pp. 79 – 90, (1999).

[8] J. Hooper, J. O'Connor, R. Cheesmar, and C.P. Price, "Tutorial software for clinical chemistry incorporating interactive multimedia clinical cases," Clin. Chem. 41, pp. 1345–1348, (1995).

[9] S. Jordan, "Resource allocation in wireless networks," Journal of High Speed Networks, vol. 5, no. 1, (1996).

[10] A. Kaddouri, B. Khodabakhchian, L.-A Dessaint, R. Champagne,L. Snider, "A new generation of simulation tools for electric drives and power electronics," Proceedings of the IEEE International Conference on Power Electronics and Drive Systems, pp. 348 –354, (1999).

[11] I. Katzela and M. Naghshineh, "Channel assignment schemes for cellular mobile telecommunication systems," Personal Communications magazine, June, (1996).

[12] R. Klar and U. Bayer, "Computer-assisted teaching and learning in medicine," Int. J. Biomed. Comput. 26, pp. 7-27, (1990).

[13] C. Lalle, "A hypermedia system for parasite identification," Int. J. Biomed. Comput. 41, pp. 175–180, (1996).

[14] D.M. Laurillard, "Computers and the emancipation of student: giving control to the learner," Instructional Sci.,16, pp. 3-18, (1987).

[15] C. W. Lin and Y. B. Lin, "Development of a PCS handoff simulator," Master Thesis, Department of Computer Science, National Chiao-Tung University, June, (1997).

[16] W. Lin, C. C. Chiang, H. K. Wu, V. Jha, M. Gerla, and R. Bagrodia, "Parallel simulation on environment for mobile Wireless Networks," in Proceedings on Winter Simulation Conference, (1996).

[17] H. Pasterkamp, "Computer assisted learning of chest auscultation: the respiration acoustics laboratory environment," in: van Bemmel, Zvaronova (Eds.), Knowledge, Information and Medical Edu-cation, Elsevier, North Holland, pp. 244–251, (1991).

[18] M. Piccolotto and O. Rio, "A computer-based teaching tool for structural design," Materials Science and Engineering A196, pp. 109-120, (1995).

[19] L. Polwman, "An ethnographic approach to analyzing navigation and task structure in interactive multimedia: some design issues for group use.," In A. Monk, D. Diaper and M.D. Harrison (eds.), People and Computer VII. Cambridge University Press, Cambridge, UK, (1992).

[20] J.B. Pugliesi and S.O. Rezende, "Intelligent hybrid system for a training and teaching environment," ICCIMA '99. Proceedings. Third International Conference on Computational Intelligence and Multimedia Applications, pp. 148-152, (1999)

[21] F. Puppe and B. Reinhardt, "Generating case-oriented training from diagnostic expert systems," machine-mediated learning 5 (3,4), pp.199– 219, (1995).

[22] J. Short, R. Bagrodia, and L. Kleinrock, "Mobile wireless network system simulation," ACM Mobile Communication Networking Conference, November, (1995).

[23] K. Tait et al., "Sim/10 first intermediate report on authoring tools for simulation," DELTA project D1014 SAFE, (1989).

[24] P. van Rosmalen and J. Hensgens, " The use of computer simulations in training," Materials Science & Engineering - A - Structural Materials: Properties, Microstructure and Processing, Volume: 199, Issue: 1, August 1, pp. 109-120, (1995).

Simulating Engineering Professional Practice Using an Interactive Web-based Resource: A Virtual Engineering Consultancy Company (VECC)

Robert M. Corderoy[*] **and Paul Cooper**[**]
[*]*Centre for Educational Development and Interactive Resources*
E-mail: bob_corderoy@uow.edu.au
[**]*Department of Mechanical Engineering, Faculty of Engineering*
E-mail: paul_cooper@uow.edu.au
University of Wollongong. Australia

A well designed PBL environment can assist and support students in building heuristics that will enhance their ability to solve problems in the real world. Problem based learning is situated in the context of a meaningful 'real world' based environment which draws on 'real variables' without the 'risk factor' normally associated with everyday practice. It poses an ill-structured, 'real world' based problem which drives the learning. Posing the problem before learning takes place provides relevance, challenge and interest, and is a powerful motivational strategy. This paper reports on the development of an on-line, problem based learning (PBL) environment (the VECC) in which students develop and practice engineering consultancy skills. Evaluation of the pilot implementation with 3rd year Engineering students at the University of Wollongong is briefly outlined. The VECC models the skills and processes of an 'expert consultant' "a professional engineer" in the field of Heat Transfer within a supported learning environment so that 'novice' student's develop appropriate problem solving skills vital for their later engineering practice. The power of a web-based environment to provide platform which supports both synchronous and asynchronous computer mediated communication enables students to interact with a virtual client in an environment which is "safe" and highly flexible.

Key Words: **Problem based learning, virtual environments, problem solving, consultancy, virtual client.**

1 Introduction

Traditionally, students graduating from engineering courses have had limited if any exposure to the wide range of practical skills centred on 'real world' contextualized problem solving and client contact which engineers must have 'in the filed' to be successful. There are many reasons for this, often based in the pedagogical approach characteristic of the institution in which they are trained. Providing a 'risk free' and cost effective environment in which students may develop and practice such skills is perhaps the other major influencing factor. A possible solution to this impasse is to provide a means of developing and practicing these skills using simulated environments.

Universities and other tertiary institutions throughout the world are rushing to embrace alternative delivery methods, particularly those that utilise the versatility and power of the World Wide Web. This is in response to the globalisation of education, the recognition of the need to provide mechanisms which will maximise opportunities for and support life long learning and the need to expand the boundaries to encompass educational experiences which are set in 'real world' contexts. The scope and boundaries for what is possible in such environments is limited only by the imagination of developers and the limitations of the web in its present form. The web is a dynamic medium whose boundaries are being extended almost daily.

Further, suggests Burnett (1997) [3], the use of the Web will continue to expand as it becomes more stable, easier to use and more accessible to everyone. What we are learning from using the Web today will provide the confidence and expertise to take advantage of the advances in its technology. Now is the time according to Alexander (1995) [1] to stop focussing on the technology itself and to start focussing on what students are to learn, and the best way for them to achieve these learning objectives. This indeed was one of the key issues of "Secrets of On-line Teaching".

In recent times many of these institutions have experimented with the use of on-line delivery with the purpose in mind of extending access to educational experiences to a wider audience on a any time, any place basis. In many cases, the results have been less than satisfactory and have fallen short of student expectations for a number of reasons. The problem is exacerbated by a number of factors. These include: time and funding restraints; the often unjustified self perception of expertise in the field and the mistaken belief by many that, putting a subject or teaching resource on-line involves little more than providing content as a web based document. Given that this situation will probably not change in the foreseeable future, how can we as teachers/designers/developers ensure that our web-based resources are effective, efficient and supportive life long learning?

"An understanding of the techniques and protocols of on-line teaching and learning and the processes of both the design of new and the conversion of pre-existing resources has become essential for academics, as universities throughout the world embrace alternative delivery methods in response to the globalisation of education." Corderoy & Lefoe (1997) [5]

2 Design Issues for On-line learning Environments

An integrated online environment such as the VEEC provides a set of tools, systems, procedures and documentation that facilitates the occurrence of any or all parts of the learning experience using some form of computer mediated communication. Moving to web based delivery of a subject or any aspect of that subject will carry with it the need for both the designers and the teachers to recognize and act on the many issues associated with such environments.

The logistics of setting up and running this type learning experience mirrors the issues that are addressed in setting up any on-line course. In general the issues can be identified as belonging to three basic categories identified in any on-line learning environment, namely technical support, pedagogical and equity issues.

Some of the more important issues include:

- Interface easy to use and navigate
- Bandwidth limitations
- Security and submission of work
- Equity of access to the technology
- Unfamiliar format for some - provide time to adjust
- Lecturer's participation - make regular contact - ensure all have accessed by a certain time
- Lecturer's willingness to moderate/facilitate collaboration
- Consider cultural differences
- Work load changes for lecturer
- Perceived inequality of experience

Of these, the authors single out technology problems including access, interaction and communication and workload as being crucial to successful learning outcomes for students working in on-line environments

2.1 Technology

The students need to be 'trained' in the basic use and operation of the technology before they start and this is often best achieved by 'face to face' instruction at the start of session. As a good rule of thumb, problems are minimised by designing to the 'lowest common denominator' in terms of available technology. Related to this aspect is the equity issue of student access.

2.2 Interaction/Student Participation and Enthusiasm

One of the most significant challenges for those using on-line teaching environments is the 'silent student'. Ensuring that the students engage in the learning is closely related to the degree of interactivity fostered between students and their peers as well as between the students and the instructor. Success in the latter is dependent upon an instructors commitment to providing 'rapid feedback' to submitted tasks and posed questions as well as regular personal 'checking in' on-line. Such commitment provides an incentive for all students to be active and enthusiastic.

2.3 Resources/Time and Workload

There is a need to consider carefully the design and structuring of on-line environments, particularly those which already exist in a traditional format. Content cannot be simply 'placed on the web'. Time and effort must be spent in considering the resources and structure needed to best present the materials in the 'new environment'. Developing materials for on-line delivery is not an easy or short process. Both the teacher and the students must be committed to accepting a greater workload as a trade-off for the value of working in an environments which mirrors 'real life' situations and skills application.

3 Developing the VECC

The VEEC has been developed on a sound pedagogical basis using a team approach, utilising the specific skills of each team member. The Faculty of Engineering and the design/development team at the Centre for Educational Development and Resources at the University of Wollongong, Australia, have been involved in the development of a prototype over the past 18 months. The VECC is a highly interactive and innovative web based simulated consulting environment, based in the 'real world' problems and processes usually associated with the task of a professional consulting engineer in the area of Heat Transfer. It provides an environment which models the 'experts' heuristic's for solving the problem, facilitating the development of an appreciation and understanding of the application of the skills and processes needed in a real world consultancy in the 'novice' student. The result will be a graduate engineer who is better prepared for the 'real world' engineering practice.

This flexible, web delivered, student-centred resource provides not only training in specific technical area, but also orientation and experience in professional practice. This type of advanced training has been demonstrated to have significant benefits to students entering the workforce. Ryan *et al.*, (1996) [8]

The framework of the VECC package is modelled on the resources that one finds in a real engineering consultancy office. The consultant in such an office will have developed an expertise in their chosen field - in this case Heat Transfer - and will also undertake continual professional development. This CAL learning environment will therefore foster a positive attitude in students towards lifelong learning. Candy *et al.*, (1994) [4]

The Industrial Problem Solving Assignments are the main educational vehicle for building students' confidence in tackling real world situations and complex tasks. This feature differentiates the VECC from other engineering CAL packages. To quote Laurillard (1993) [6], "we cannot separate knowledge to be learned from the situations in which it is used". In the VECC, students will immediately see the relevance of the engineering theory to be used, since they must actively search for the appropriate theoretical model. That search is the same process the student will eventually use as a practicing professional engineer.

When using this resource the student role-plays a consultant who carries out all the managerial and technical tasks required to expedite a number of high-level Industrial Problem Solving Assignments. This problem-based learning approach "confronts the students" Boud *et al.*, (1991) [2] with 'real world' based ill-structured problems and scenarios which provide a stimulus for learning and in so doing "encourages the students to take a deeper approach to learning". Ramsden (1992) [7]. The PBL approach enriches the learning outcomes by simultaneously developing higher order thinking skills and disciplinary specific knowledge bases and skills. It promotes the student to the active 'practitioners' role in the process.

The consultant's activities include:

- negotiating with the client on cost and timetabling of the consultant's services
- obtaining the client's technical brief and tendering for the project
- sourcing technical information such as plant dimensions
- making on-site measurements of temperatures or other parameters
- student-centred learning through the Computer Aided Learning (CAL) module integral to the Virtual Engineering Consultancy Company
- simulation of real-life problems using a toolbox of simulation resources.

4 Expected Outcomes

The most significant expected outcomes for students using this web-based package include:

- A PBL based CAL resource that provides Engineering students with training in professional practice as consultants in Heat Transfer Engineering through 'virtual access' to 'virtual clients'.
- The simulated 'real world' environment that the web provides will provide them with a better understanding not only of the processes involved in professional Engineering practice but also the relationship between the Engineers and client.
- Improved effectiveness of delivery to a diverse student population of full-time, part-time and off-campus students.
- Improved skills in collaborative working and negotiation.
- Improved attractiveness of University of Wollongong Engineering graduates to potential employers.
- Flexibility in terms of meeting the course requirements with regard to time and place and individual learning styles.
- Improved opportunity for students to be active members of the cohort in all facets of the course.

5 The Pilot Virtual Engineering Consultancy Company (VECC)

To date the fundamental structure of the VECC and a substantial number of software resources (including interactive Heat Transfer simulations) have been developed. The complete package will eventually contain in excess of 30 simulations which will support and develop the students understanding and proficiency in aspects of Heat Transfer including: furnace insulation; steel quenching; conduction and boiling heat transfer.

Extensive work has also been carried out on the structuring of the 'theory section' of the package. Consideration has been given the 'chunking' of this considerable resource so as to provide a meaningful resource for the students while at the same time being 'easily accessible' within a web based environment.

The centre of the VECC resource is the consultant's office (Fig 1) that models a typical engineering office in the real world and has facilities including:

Fig 1: The VECC Consultancy Office

In summary, the VECC resource will eventually comprise three main Modules;

- **Training (CAL) Module** - the student uses resources such as simulations, text-based material, videos, animations, etc to learn the fundamentals of Heat Transfer theory.

- **Trouble-shooting Module** - here the student has to solve challenging real-life problems that are far more in-depth than conventional engineering assignments. In an example already developed, the student's client is a corporation that has just built and commissioned a large hydrogen production furnace. The furnace is overheating and the student must find out why, suggest remedial measures and act as an expert witness in a court case.

- **Design Module** - Students design a number of pieces of thermal equipment to satisfy a specification from their client. Examples will include a transistor heat sink and car radiator. The detailed design of thermal equipment is not a topic normally covered in an undergraduate course on Heat Transfer perhaps because it requires a problem-based learning approach and yet it can be one of the most rewarding aspects of an engineering student's study.

- A **project management whiteboard** that will be automatically updated as a student progresses through the study programme.

- A **laptop computer** which is the virtual gateway to the web and provides contact with the clients (the lecturer) for each project, resources external to the VECC and the brief containing full technical details. (Appendix 1)

- A **video monitor** for access to video clips of site visits, illustrative fluid visualisation experiments, lecture presentations, etc.

- A **desktop computer** which represents a powerful computing resource where the heat transfer simulations are located. These already include four unique simulations of important conduction heat transfer situations. Each simulation deals with a real world problem and will be used as part of the consultant's exploration of the case studies.

- A **telephone** for initial contact with the consultant's clients achieved using an audio track.Hello, Chris Garbutt here. I'm the Engineering Manager of Heat Treat TM. Our company deals with a large variety of construction projects involving thermal and chemical processing. We struck some heat transfer problems with one of our projects involving a furnace that is not operating as was planned and we're asking your consultancy firm, along with others, to tender for a trouble shooting role in fixing the problem.

  If you are interested in taking on this challenging consultancy, a brief containing full technical details of the project at our company's web site can be accessed through your laptop computer. I hope you can help us out. Please E-mail me if you have any queries. Bye for now.

- A **virtual library** of books which is the link into the CAL module where the student explores the topic of Heat Transfer through the problem-based learning approach of the VECC.

6 Pilot Evaluation

Students who took part in the pilot implementation had access to a limited prototype version of the 'complete' site. At this stage of its development, some of the segments of the VECC exist as discrete units that are independent of the overall structure. It was expected that this may cause some navigational/continuity problems for some students, however early anecdotal evidence collected from the students seems to suggest that this was not the case. Approximately 80 3^{rd} year engineering students (20 groups comprising 3 or 4 students each) used the VECC to complete a major assignment during semester 1. Each group consulted in various degrees with the client using the E-mail link, used the various resources available within the consultancy office to support their investigations and develop their 'solutions' to the 'posed problem'.

Data collected during this pilot includes: student interviews and comments including a special forum where technical issues and the learning processes were discussed; lecturer's observations; archived E-mail communication between the lecturer and students and; individual marks awarded to students together with the lecturer's 'quality of answer' evaluation.

6.1 The Students' perceptions

Comments made by students to the lecturer include:

- convenient and easy to use;
- provides for flexibility in their study schedules;
- provides access to a greater richness of resources;
- helped them develop an understanding of the issues critical to client management;
- motivating;
- provides time to consider actions and issues
- allowed them to develop collaborative networks
- use of a real world problem put the theoretical concepts learned and the analytical skills developed into the context of their future activities as professional engineers and;
- comfortable working in this delivery mode.

6.2 The Lecturers' perceptions

Although at this early stage in development there is no longitudinal data for comparison, the lecturer is confident that data to be collected during the continued development and use of the VECC will support and re-enforce observations made so far including:

- overall performance of the majority of groups is better than past years, not just in terms of the overall mark but in the quality of the answers;
- role play appears to have contributed to a deeper understanding of the problem and possible solutions and enriched the learning experience;
- there has been no change in the completion rate, the number of students 'opting out' is about the same as usual;
- students who took full advantage of this support by contacting the 'client' (lecturer) performed better than those who did not;
- seems to be a time efficient way of presenting both the technical information and the processes involved in consultancy in a richer environment;
- flexibility for both students and lecturer is a 'real plus' and;
- the students seemed to be more motivated and this is reflected in their willingness to explore the resource base fully, developing better quality answers.

7 Future directions

There are several issues unique to technology based delivery which need to be investigated with respect to the VECC. The student groups had minimal exposure to the 'structure' and process of the VECC in lectures. Did this add to the cognitive load placed on them so that unnecessary effort was expended on learning about the system, rather than from it? Experience shows that with poor design, there can be an enormous increase in the cognitive load for students and the result is a poorer outcome than expected. To address this, it is envisaged that an extensive help system will be provided within the package. Specific lab sessions prior to using the system will also be run to allow students time to become familiar with the package. Such 'user support' mechanisms are an essential part of complex learning systems and it is essential that all students avail themselves of it. Ensuring that they do is one of the keys to facilitating useful student interaction with the learning environment. The issue of preferred learning styles and the 'students' fit' to the delivery mode needs to be explored.

8 Conclusion

Flexible modes of delivery such as Web based instruction can provide an effective means of addressing the problems of increasing student demands, decreasing funds, the need to establish a presence in the international market place and rapid technological change. The rapid rise in the development of sophisticated and improved technologies has been the driving force behind the widespread embracing of the concept of flexible delivery and the application of the many and varied tools upon which it is based in the field of education and life long learning. The VECC is a web based flexible learning tool which provides students with 'real world' based experiences in professional practice. Early indications suggest that students are benefiting from this virtual consultancy learning environment which uses a problem based learning approach to develop the skills which are vital to engineering practice in the real world.

References

[1] Alexander, S. (1995) Teaching and learning on the World Wide Web. *Proceedings of AUSWEB95 The First Australian World Wide Web Conference*, Southern Cross University, Lismore. Australia.

[2] Boud, D. & Faletti, G. (1991) (eds) The Challenge of Problem-Based Learning. Kogan Page, London.

[3] Burnett, D. (1997) TiLT Seminar Series – Confessions of an Online Teacher. http://www.scu.edu.au/services/tilt/tsf/on/dale/bsemsummary.html

[4] Candy, P. Crebert, G. & O'Leary, J. (1994) Developing Lifelong Learners through Undergraduate Education. *NBEET Report No 28*, Canberra.

[5] Corderoy, R. M. & Lefoe, G. (1997) Tips and Secrets for Online Teaching and Learning: An inside View. *Proceedings of ASCILITE 97*. Perth.

[6] Laurillard. D (1993) Rethinking University Teaching: A framework for the effective use of educational technology. Routledge. New York

[7] Ramsden. P. (1992) Learning to Teach in Higher Education. Routledge, London.

[8] Ryan G, Toohey, S. & Hughes, C. (1996) The purpose, value and structure of the practicum in higher education: A literature review. *Higher Education 31*, 355-377.

Appendix 1

YOUR BRIEF

Heat Loss Calculations

If you choose to accept this assignment HeatTreat requires you to:

- to calculate the total heat loss from the furnace walls and roof (as a first approximation assume a outside surface heat transfer coefficient to be 20W/m^2 including both convection and radiation heat transfer)
- to calculate the interface temperature between the Zirconia Blanket and the Mineral Wool to ensure that the latter does not overheat.

Surface Temperatures

The client has measured outside temperatures on the outside of the furnace to be in the range of 105 to 170°C. These are potentially very hazardous. You must perform the following tasks. A map of some of the surface temperature measurements is shown below.

Outside Wall Temperatures

Furnace level	1	2	3	4	5	Floor
Mean outside surface temp (°C)	**75**	**64**	**68**	**70**	**68**	**52**

a) Carry out a sensitivity analysis of one of the wall the surface temperatures to the outside heat transfer coefficient (calculate the expected radiation heat transfer coefficient assuming emissivity, $\varepsilon = 1$, and then vary the convection heat transfer coefficient in a range that would be expected under normal weather conditions ie between 5 and 20W/m^{2}K, say).

b) Determine whether the firebrick insulation shown in the design drawings is likely to have been put in place correctly (if the insulation has not been properly installed legal action may be taken against the insulation installation sub-contractors). Assume the flue duct wall temperature is equal to the gas temperature of Section 6 of the furnace.

c) Recommend a solution to these high surface temperatures problems. Some possibilities include:
Add extra insulation to outside of furnace (you must calculate how much must be added and whether the resulting temperature of the structural steel is within acceptable limits).
Shut down furnace and replace internal insulation in problem areas (very much a last resort represents a very high cost option).?

Summarise your recommendations.

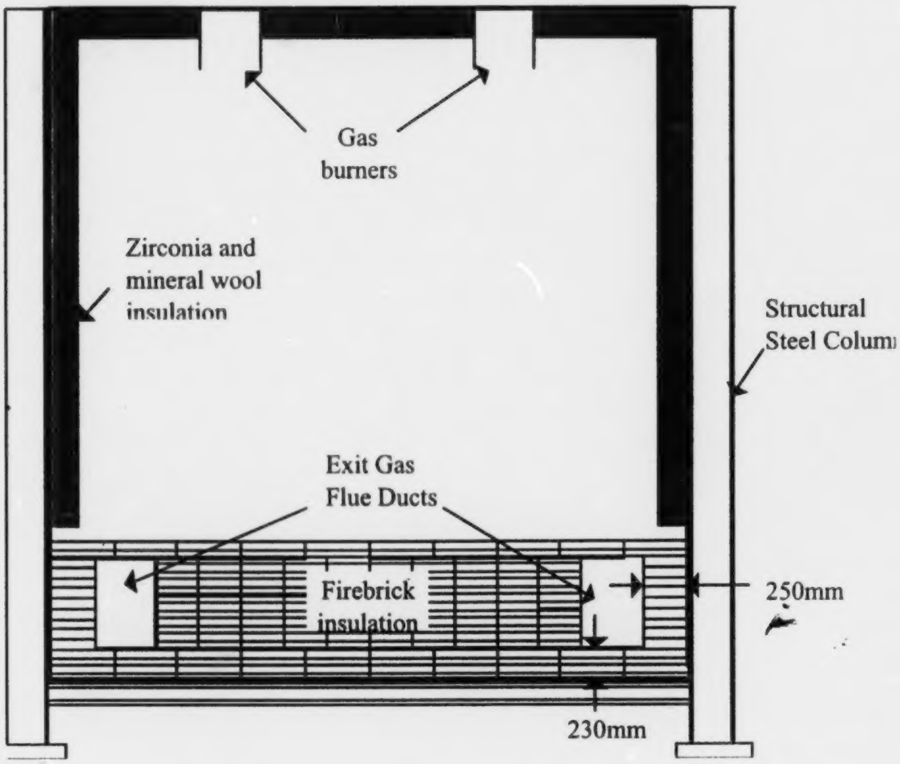
Further information

It is up to you to source any further information that is required. Local sources of information include:

- the training module "Conduction Heat Transfer" on your desk
- thermophysical data of various materials in the appendix of "Conduction Heat Transfer"
- simulations and video footage available on the desktop computer and video screen.

Remember that obtaining relevant information is often a critical task in high level engineering work and decision making.

If you require specific information on this Brief please contact your client at the following E-mail address. Paul_Cooper@uow.edu.au.


Gas
burners
Zirconia and
mineral wool
insulation
Structural
Steel Colum
Exit Gas
Flue Ducts
Firebrick
insulation
250mm
230mm

Layout of furnace insulation and structural steel.

Student Use of Learning Strategies in Web-Based Courses

Ching-Chun Shih* and Ann D. Thompson**
Iowa State University
**E016 Lagomarcino Hall, Ames, IA 50011, USA*
Tel: +1-515-294-1941
Fax: +1-515-294-9284
Email: ccshih@iastate.edu
***N131 Lagomarcino Hall, Ames, IA 50011, USA*
Tel: +1-515-294-5287
Fax: +1-515-294-6206
Email: eat@iastate.edu

The purpose of this paper is to present the preliminary analysis of student learning strategy use in Web-based courses provided by the Master of Science in Agronomy Distance Education Program at Iowa State University, U.S. This study involved 28 students taking 8 courses of this program in the fall of 1999 and spring of 2000. Each student was asked to report their learning strategy use for each lesson they took. The 9 learning strategy categories developed by Pintrich, Smith, Garcia, & McKeachie (1991) were used to classify students' use of learning strategies. It was found that students used most of the organization, rehearsal, and metacognitive self-regulation learning strategies and least of the critical thinking strategies. None of the peer learning and help seeking strategies was reported in the Reflective Learning Journals. The learning strategies students used to cover the learning materials, such as taking notes, viewing the lessons via the CD-ROM/WWW, and doing the reading before viewing the lessons, were the most frequently reported strategies in students' Reflective Learning Journals. Future research is needed to investigate and survey student use of learning strategies and to differentiate student use of learning strategies between high achieving and low achieving students.

Key words: **Web-based learning, learning strategies, reflection**

1 Introduction

The latest in the long line of learning technologies is the World Wide Web (WWW). As the WWW is becoming popular, its use as means of delivering instruction is also growing. The World Lecture Hall lists over 1000 courses that are delivered by higher educational institutions via the Web, and this list is growing daily (World Lecture Hall, 2000). However, Alexander (1998) argued that research questions about application of new technologies should not be in terms of media such as print, video, computer, or face-to-face instruction. The most important question should be: what is known about the ways students learn via the new technology.

Identifying students' learning strategies can help educators understand how students process learning materials in different ways. According to Cross and Steadman (1996), learning strategies are behavior skills which learners can use to improve their understanding, integration, and retention of new information. Learning strategies include a wide variety of cognitive processes and behavioral skills (Weinstein & Meyer, 1991). Pintrich and his colleagues developed a learning strategy instrument, Motivation Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia & McKeachie, 1991). This instrument includes two main sections: one on motivation and one on learning strategies. The learning strategy section consists of nine learning strategy categories. They are: rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help seeking

(Pintrich, Smith, Garcia & McKeachie, 1991). The description of the 9 learning strategy categories are listed as follows:

(1) Rehearsal: Basic rehearsal strategies involve reciting or naming items from a list to be learned.

(2) Elaboration: Elaboration strategies help students store information into long-term memory by building internal connections between items to be learned.

(3) Organization: Organization strategies help the students select appropriate information and also construct connections among the information to be learned.

(4) Critical thinking: Critical thinking refers to the degree to which students report applying previous knowledge to new situations in order to solve problems, reach decisions, or make critical evaluations with respect to standards of excellence.

(5) Metacognitive self-regulation: There are three general processes that make up metacognitive self-regulatory activities: planning, monitoring, and regulating.

(6) Time and study environment: Time management involves scheduling, planning, and managing one's study time. Study environment management refers to the settings where the students do the class work.

(7) Effort regulation: Effort regulation is self-management, and reflects a commitment to completing ones' study goals, even when there are difficulties or distractions.

(8) Peer learning: Dialogue with peers can help a learner clarify course material and reach insights one may not have attained on one's own.

(9) Help seeking: Another aspect of the learning environment that students must learn to manage is the support of others. This includes both peers and instructors.

In the fall of 199, the Master of Science in Agronomy Distance Education Program at Iowa State University, U.S. started providing interactive multimedia courses in which most course materials and resources were accessed and delivered through the WWW and CD-ROM. One of the goals of this program was to provide a way for professionals working in industry and the government to gain an advanced degree in Agronomy without having to attend the campus in person. The curriculum consists of 12 courses, a 1-credit workshop, and a 3-credit creative component, which totals 30 semester credits (Iowa State University, 2000). The courseware integrates content material on CD-ROM/WWW with the interactive tools of WebCT (WebCT, 2000) on an ISU server. The WebCT tools allow students to interact electronically with their instructors and classmates by utilizing a course calendar, discussion board, chat room, student homepage, assignment, emails, and student records. The program began with an enrollment of fifteen students in a pilot program in 98/99 academic year. In the fall of 2000, Eighty-one students are enrolled in the program.

What do we know about the ways students learn via the new technology, the WWW? What are the learning strategies used by students in the Masters of Science in Agronomy Distance Education Program? To answer these questions, research on the learning strategies used by students in Web-based courses is needed. This type of research will assist educators in delivering quality Web-based instruction in a manner that will help students become better learners in distance education.

2 Purpose

The purpose of this study is to report the preliminary analysis of learning strategies used by students in Web-based courses provided by the Maters of Science in Agronomy Distance Education Program at Iowa State University in U.S.

3 Methods

The study involved 29 students taking 8 Agronomy courses provided by the Mater of Science in Agronomy Distance Education Program in the fall of 1999 and spring of 2000. Each student was asked to complete a Reflective Learning Journal for each lesson. Usually, each course consists of 15 lessons per semester. Four open-ended questions were included in the Journal. They were: (1) Summarize the major points of this lesson; (2) What is the most valuable concept you learned from the lesson; (3) What concepts in the lesson are still unclear to you; and (4) What learning strategies did you use in this lesson? Using student responses to the last question, this paper focuses on studying the student use of learning strategies. The 9 learning strategy categories in the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991) were used to classify students' use of learning strategies.

4 Results

Regarding the use of learning strategies, most of the students reported that they finished the assigned readings before the lesson; took notes while viewing the lessons; viewed the lessons on CD/WWW at a fixed schedule; printed off the lesson content on CD/WWW including text, diagrams, pictures, graphs, and study questions for future review; read the textbook and viewed the lessons more than one time; used notes to review the lessons; and kept up with weekly readings or assignments. In addition, many students did a quick read-through before they viewed the lessons; restudied the parts of the lessons that were not clear during the first time; related the concepts they had learned from the previous lessons; and made progress on a daily bases. Most interestingly, one student even copied illustrations from the lessons every week and saved them to his computer desktop as wallpaper for quick reference. He said, "[the wallpaper] sometimes helps my memory and understanding." Another student reported that he needed to find quiet time to study and avoid distraction of the family members. In his journal, he wrote that, "quiet time when our new baby is not crying enhances learning! I have to admit that mom is doing a great job in that department for me!"

Learning strategies reported in students' Reflective Learning Journals were analyzed and classified according to the 9 learning strategy categories developed by Pintrich et al. (1991) (See Table 1). Students used most of the organization, rehearsal, and metacognitive self-regulation learning strategies and least of the critical thinking strategies. None of the peer learning and help seeking strategies was reported in students' Reflective Learning Journals. However, 10 learning strategies did not fit into Pintrich's categories. They were the strategies that students used to "take" the lessons either through CD-ROM or WWW, and try to cover and understand the learning and reading materials. These were the most frequently reported learning strategies in the Reflective Learning Journals.

Table 1. List of learning strategies used by students

Learning strategy Category[1]	Learning strategies used by students
1. Rehearsal	1. Highlight the key topics of the lesson to refresh my memory
	2. Read the textbook more than one time
	3. View the lessons more than one time
	4. Review information posted on the discussion board
	5. Review my notes and information posted to the discussion board
	6. Copy all the questions to my Word file before working through the lesson to help me memorize the key concepts
2. Elaboration	1. Correct/annotate my notes later after I take them
	2. Write out a narrative summary of the lesson
	3. Use other sources of information, e.g., personal reference texts, Internet, to improve understanding of the lesson material
	4. Do cross-referencing between lessons and put things together
	5. Analyze my answers to the assignments/study questions
3. Organization	1. Make simple charts to organize my material
	2. View the chapter headings to obtain the purpose of the lessons
	3. Use my notes to review the lessons and as a study guide
	4. Relate the concepts I have learned from the course
	5. Use lesson objectives to determine the important factors in the lesson
	6. Re-organize my notes for future review
	7. Do discussion topics to tie things together
	8. Ask myself how the current topic relates to all the topics I have learned in the previous lessons
4. Critical thinking	1. Question the answers that were given by the classmates/instructor
	2. Use note cards for glossary of terms to quiz myself
5. Metacognitive self-regulation	1. Quiz myself on what the key focus of the lesson
	2. Review some of the last lesson to allow better understanding of overall plan
	3. Use quiet time and avoid distraction of the family members

	4.	Use the Reflective Learning Journal as a study guide and review outline of the lesson
	5.	Go back to textbook and lessons to clarify my questions
	6.	Restudy the parts of the lesson that were not clear on the first time
6. Time and study environment	1.	Spend certain amount of time reviewing material every day
	2.	Complete all the assignments before the due dates
	3.	Study the lesson in a regular basis each week
	4.	Study the lesson at a fixed schedule
7. Effort regulation	1.	Try to focus on some of the more difficult principles and work through them several time
	2.	Decide those least understood concepts and spend extra time on them
	3.	Print off my computer notes and add my own pen-written notes on them
	4.	Print off the lessons' pages, important illustrations and study questions for later study
8. Peer learning		None
9. Help seeking		None
10. Other[2]	1.	Take notes as I read the book/CD lesson
	2.	Study all the questions ahead of time before studying the lessons
	3.	Develop a vocabulary list of terms I don't know
	4.	Do a quick read through before view the lesson
	5.	Finish readings before viewing the lessons via CD-ROM/WWW
	6.	Visualize the processes of the concepts in the lessons
	7.	Copy illustrations from the CD/WWW lessons and save them as wallpaper on my computer
	8.	Read the lessons very slowly and carefully to make sure I understand the material clearly
	9.	Spend a portion of my time reviewing all pictures, charts, graphics to make sure I really understand what they are presenting
	10.	View the discussion as posted by the classmates

[1] Learning categories that are based on Pintrich, Smith, Garcia, and McKeachie (1991)
[2] Learning strategies that did not fit Pintrich's et al. categories

5 Conclusions

In conclusion, a variety of learning strategies were found in the Reflective Learning Journals. In this distance education program, students tended to use more of the organization, rehearsal, and metacognitive self-regulation learning strategies and least of critical thinking strategies. However, none of the peer learning and help seeking strategies was reported. The learning strategies students used to cover the learning materials, such as taking notes, viewing the lessons, and doing the reading before viewing the lessons via the CD-ROM/WWW, were the most frequently reported individual strategies in students' Reflective Learning Journals.

This study provided a good basis for the instructors of this distance education program to understand how individual students learned via CD-ROM/WWW. However, in order to ensure student success in Web-based instruction, future research is needed to survey student use of learning strategies and correlate student use of learning strategies with their achievement. Additionally, it is necessary to differentiate student use of learning strategies between high achieving and low achieving students. To date, the researchers are developing a learning strategy instrument based on the results of this study. The results of the survey study will be posted in the program website to inform the learning strategy use by the high and low achievers in the program. This will help students learn how to learn and become better learners in the Web-based learning environment.

References

[1] Alexander, S., "Teaching and learning on the World Wide Web", http://www.scu.edu.au/ausweb95/papers/education2/alexander/ (accessed on August, 1998).

[2] Cross, R. C., & Steadman, M. H., "Classroom research: Implementing the scholarship of teaching," San Francisco: Jossey-Bass Publishers, (1996).

[3] Iowa State University, "Master of Science in Agronomy Distance Education Program," http://masters.agron.iastate.edu, (accessed May, 2000).

[4] Pintrich, R., Smith, D. A. F., Garcia, T., & McKeachie, W. J., "Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ)," Educational and Psychological Measurement, Vol 53, pp. 801-813, (1991).

[5] WebCT, http://webct.cc.iastate.edu:8900/ (accessed May, 2000).

[6] Weinstein, C. E. & Meyer, D. K., "Cognitive learning strategies and college teaching," College teaching: from theory to practice, New directions for teaching and learning, No 45, pp.15-26, (1991).

[7] World Lecture Hall, http://www.utexas.edu/world/lecture/ (accessed May, 2000).

Students' Attitude toward WPSS in Supporting Classroom Learning

Hsiu-Ping Yueh
Department of Agricultural Extension, National Taiwan University,
#1, Sec. 4, Roosevelt Rd, Taipei 106, Taiwan
Tel: 886-2-23630231-2750
FAX: 886-2-23647221
Email: yueh@ccms.ntu.edu.tw

While the web-based learning environment has become more flexible and has more functions than traditional instructional media as well as many computer-assisted instruction, the EPSS has also become an expanding area within the field of education. This paper first describes the features of and rationale behind electronic performance support system as well as web-based performance support system; demonstrates the implementation of the web-based performance support system in assisting students' learning in a real-time multicast distance classroom; discusses the research methodology; explores the effectiveness of the use of the web-based performance support system in supporting students' learning; and provides conclusions and implications for the filed of education.

Key Words: **Distance Education, Electronic Performance Support System (EPSS), Web-based Performance Support System (WPSS)**

1 Introduction

Electronic Performance Support System (EPSS) was originally defined as a system that provides just-in-time information, advice, learning experiences, and tools in the form of electronic to help people perform a task with the minimum support from other people [3]. Based on the early definition, EPSS was perceived by many people as an interactive computer-based environment which attempts to facilitate or improve human performance such as problem solving abilities within some target application domain. To help organizations design and develop EPSS with a broader systems thinking approach, Raybould (1995) proposes that an EPSS is "the electronic infrastructure that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable an individual to achieve a required level of performance in the fastest possible time and with the minimum of support from other people"(p.66)[6].

A number of existing technologies have been selected and integrated into design and development of an EPSS, such as artificial intelligence (AI), hypermedia, computer-based training (CBT), intelligent tutors and microworlds [5]. With the impact of the growth and development of network technology, internet or intranet has become one of the most important delivery vehicle for the EPSS. A Web-based Performance Support System (WPSS) is an innovative approach by utilizing the technologies of the world-wide-web (WWW). For a WPSS, the web is not only a delivery medium, it also provides contents and serves as subject matter experts (SMEs) as well. The DISTED (Distributed Information System & Training for Educators at a Distance Education) as an example of a WPSS has successfully functioned as a system which helps educators design, delivery and evaluate teaching in the interactive distance education [7]. The WPSS has been proved to be a better design than the traditional EPSS in terms of it's features such as cost-effectiveness, open architecture, universal acceptance and pervasive delivery [2].

Many training experts contended that Electronic Performance Support Systems are the learning tools of the 21st century [4]. While most of the major developments and applications of EPSS were designed for industrial and commercial settings, more and more educators in many academic organizations have begun to adopt the concept and implement EPSSs in their classes. As the educational environment becomes more dynamic, the possibility of adequately imparting necessary knowledge to learners within a limited instructional schedule is increasingly challenging. Considering that our knowledge base is expanding rapidly and information is being updated at the speed of telecommunications, some educators therefore started to employ an integrated use of EPSS to facilitate learners' information retrieval. For example, Schwen, Goodrum, & Dorsey (1993) used the EPSS to create an enriched learning and information environment [8]; Law (1994) employed the metaphor of "cognitive training wheels" to describe EPSS as it facilitates learners' acquisition of skilled performance.

According to the early definition of EPSS, there are usually four major components embedded in a performance support system which includes information, training, advice and tools. To improve the functions and the design and development of a better performance support system, many researchers proposed different models of putting together an EPSS with necessary components. Gery (1991) listed three levels of functionality with four components at each level, they are user interface, help, coach/advisor, and tutor [3]. McGraw (1995) suggested that the components of an EPSS should include the human-computer interface, the help system, the coaching/advisor system, and the tutor component [5]. Baker and Banerji (1995) proposed an approach to design and implement of EPSS facilities based upon the use of a multi-layered model containing four basic levels including human-computer interface, generic tools, application specific support tools, and application domain [1]. In general, an EPSS should have four typical components including tools, information base, advisor, and learning experiences [9] to be able to support performance.

While we are moving into the resource-based learning environment in the field of education, the way of teaching and instruction has been changed accordingly. Teachers are no longer experts but facilitators or guilders; textbooks is also instead by a variety of learning resources and media. Internet is a very good tool in terms of providing the resource-based learning environment. The world-wide web with hypertext markup language (HTML) provides an easier way to present large volumes of text electronically, using efficient client/server architecture to transfer different kinds of data, such as texts with fancy fonts, colorful graphics, even sound and video clips in packets across the internet. As an integrated tool, WWW allows users to share and transfer data files easily, as well as communicate and interact more effectively. Also as a self-directed learning tool, a WPSS provides a rich environment with up-to-date information, real-world learning experiences, as well as worldwide learning resources, with which students can self-pace, monitor, and evaluate their learning.

2 Method

The purpose of this study were to investigate the effectiveness of the WPSS in supporting students' learning as well as to understand students' attitude toward this system. The target population for this study is a class of students (82 students totally) registering in the distance education course titled "Web-based Instruction and Training" in Spring 1999. A WIT Web Site was designed and developed as a web-based performance support system to assist students' learning of this course. At the end of the semester, a copy of questionnaire was also designed and distributed to students to collect their perception toward this Web Site. Moreover, students' answers to a posttest essay of the final exam were reviewed for the purpose of evaluation. The data collected were analyzed by means of Descriptive Statistics, correlation, and regression study.

3 Results

For the attitude survey, most students showed positive attitude toward content information (usefulness, richness, helpfulness), format design (screen design, visual images design, layout consistency, links arrangement), and composition (organization, presentation, delivery, references) of this WIT Web Site. Besides, students' comments also showed that most students thought this Web Site is a useful tool in general especially it meets different learning needs of students. Furthermore, the results showed that there is a moderate correlation between students' attitude with their final exam scores. And findings suggest that most students are willing to use this kind of supporting system in their learning if other courses could provide in the future.

4 Conclusions

1. Evidence from students' attitude survey and feedback comments shows that the web based performance support system is a powerful tool in terms of assisting learning especially in the distance education learning environment. It serves as a self-directed learning tool with which students can self-pace, monitor, and evaluate their learning, which may in turn facilitate students in developing life-long learning skills.

2. Results of this study also shows that the WIT Web Site provides a powerful communication channel between instructor and students, as well as students at different learning sites in the distance education course. More specifically, the web-based discussion boards were claimed by students to be a very useful tool to expand the interaction and communication outside classroom.

3. Most Electronic Performance support Systems were used in the industrial settings in the past, however, results of this study has approved that a WPSS can also be an excellent tool for providing just-in-time assistance in the learning environment of formal education. Students perceived it as a good learning tool in many aspects including the application to future study in other contexts or subject areas. This experience of facilitating students learning on the internet can be applied in other curriculum at different levels of schools.

Reference

[1] Baker, P., & Banerji, A., "Designing electronic performance support systems, Innovations in Education and Training International, 32(1), 4-12. (1995)

[2] Chang, C. C. (1999). Designing, developing and evaluating an electronic performance support system for performing and learning instructional designing tasks. In G. Cumming et al. (Eds.), Advanced Research in Computers and Communications in Education (Vol. 2, pp. 423-426). Ohmsha: IOS Press.

[3] Gery, G., "Electronic performance support systems: How and why to remake the workplace through the strategic application of technology". Tolland, Mass: Gery Performance Press. (1991).

[4] Hoyt, B.R., Stockman, M., & Thalmann, J., "Design and implement custom electronic performance support systems (EPSS) for training in project based classes. ASCUE Proceedings, 100-107. (ED document 410925) (1997)

[5] McGraw, K.L., "Selecting appropriate functionality and technologies for EPSS, Innovations in Education and Training International, 32(1), 13-22. (1995).

[6] Raybould, B., "Making a case for EPSS, Innovations in Education and Training International, 32(1), 65-69. (1995)

[7] Remmers, E. (1998). Guidelines for WWW-based support environments for education professionals. URL: http://mw75.student.utwente.nl/~elka/litstudy/

[8] Schwen, T. M., Goodrum, D.A., & Dorsey, L. T., "On the design of an enriched learning and information environment (ELIE). Educational Technology, 33(11), 5-9. (1993)

[9] Yueh, H., Liu, F., & Wang, P., "Assessing the effectiveness of a web-based EPSS. Paper presentated at the Annual Conference of the Association for Educational Eommunication and Technology, St. Louis, MO. (February, 1998).

The analysis of social discourse in a network-based learning community --The GeoSchool Experience

Fe-ching Chen *and Huo-Ming Jiang**
**Center for Teacher Education National Central University*
Chung-Li, Taiwan 320
E-mail: fcc@cc.ncu.edu.tw
***Institute of Atmospheric Science National Central University*
Chung-Li, Taiwan 320
E-mail: Jiang@front.atm.ncu.edu.tw

This paper is the first of a series of papers introducing the GeoSchool Project, a complex study to construct a network-based Earth Science learning environment for high school students. The set of papers will cover the following topics: (1) the theoretical foundations and research methodology; (2) data collecting and investigation software tools for visualization and quantitative analysis; (3) the project-based learning model; (4) issues raised by network-based learning experiences versus traditional classroom experiences; (5) the learning portfolio and social discourse; (6) the results and their implications. While in this paper we are focused on the analysis of social discourse and its implications in the GeoSchool experiences. 2685 articles were analyzed to discover the characteristics of the social discourse in the learning activity on the web. These articles were posted by 15 high school students and 10 mentors during a 15-day study on atmospheric science on the web. This is a study of the learners' authentic interactive process. The examination of the actual initiation and diminishing of threads in the social discourse reveals not only the characteristics of a network-based learning community mainly consisted of high schools, but also important scaffolding issues in the inquiry process. The paper looks into the following issues: What were the major categories of the 2685 posted articles? What kind of questions the learners asked? What kind of questions brought in replies and what didn't? What were the major categories of the mentors' articles? How could the mentor's scaffolding be helpful? What were the characteristics of the longer discussion threads? How could the learners scaffold each other? … etc. After answering these questions we could then look into the broader aspects of a network-based learning community, namely, what influences did the network based learning environment have on the inquiry-based learning process of the high schools, what could we learn from the mentor-learner interactions, when did meaningful learning actually take place.

Keywords: **learning community, scaffold, mentor, Geoschool, social discourse posted articles**

1 Introduction

The thought that network-based learning environment facilitates learners to construct their own knowledge, to be reflective, and to be socially interactive has been fruitfully applied to science learning. The implication of inquiry learning in network-based learning environment also presents a number of significant challenges (Edelson, Gordin, & Pea, 1999). However, research on this field seldom showed a picture in detail of learners' interactions in such a technology-supported environment. Our goal has been to explore realistically what is the shared learning experience high school students might have and how do they articulate their own understanding, comment on each other's thoughts, and bear distributed expertise.

In this paper, we will describe and classify the articles posted on the network by both the learners and the mentors into categories in order to reveal the underlying learning styles, obstacles and scaffolding strategies. We discovered a number of characteristics of the learners' learning style and the social discourse in the network-based learning community.

2 THE PROJECT-BASED LEARNING MODEL

Over the past 3 years, the authors have been engaged in the development of cooperative project-based learning (PBL) environment of GeoSchool (http://geoschool.ncu.edu.tw). According to the definition of Krajcik (Krajcik, et al, 1998), the features of PBL learning include (a) a driving question; (b) investigations and artifact creation; (c) collaboration; (d) use of technological tools. The PBL in our GeoSchool is designed to facilitate five stages of inquiry and three steps of Co-op Jigsaw II (Kagan, 1992) teamwork. The five stages of inquiry are: problem definition, deciding variables to use and the procedures to take, data collection, data analysis and interpretation, drawing conclusions and presenting the findings. The three steps of teamwork are to form teams, to form expert groups to develop individual expertise, and then to go back to the team to share expertise. Figure 1 depicts this PBL learning model.

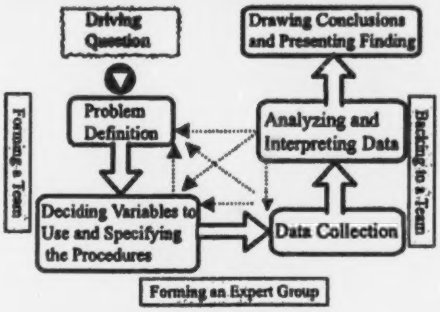

Driving Question
Drawing Conclusions and Presenting Finding
Forming a Team
Problem Definition
Analyzing and Interpreting Data
Backing to a Team
Deciding Variables to Use and Specifying the Procedures
Data Collection
Forming an Expert Group

Figure 1. Cooperative PBL model

3 ROLE OF DISCOURSE IN SCIENCE LEARNING

The two major contemporary thoughts on science education are constructivism and the reflective practice. The constructivist approach involves heavy social discourse and interactions in its problematic, action taking, and reflective stages. Although reflection can be an individual activity, it can also be a social activity to be influenced by a community. Therefore the role of social discourse in science learning is gaining more importance than before. The social discourse can be helpful throughout the inquiry based learning process. For example, the learners could be inspired in the social discourse to revise and refine their original low-level factual problem definitions for higher-level abstraction; social discourse could also lead the learners to become aware of the inconsistency between their problem definitions and the conclusions they are trying to draw.

4 METHOD

4.1 Participants and Design

Participants were 15 high school students (10 girls and 5 boys), aged 16 to 17 years old, enrolled in 9 different senior high schools located in north, middle, and south part of Taiwan separately. In addition to the students, 10 university graduates and professors majored in atmospheric science also joined and served as mentors in the inquire process. Every three students formed a team by selecting one of the several driving questions they were interested in. No more than one member can come from schools in the same area so that they would be forced to communicate through the network-based learning environment. The assignment to the teams is to investigate and answer the assigned problem with justification. At the second step, each member of a team was assigned to one of the three different expert groups. A member should go on-line to his respective expert group to inquire knowledge and to bring back to his team to finish the assignment collectively as the third step. The students were given a database of primary knowledge source on CD containing background theories and factual data but not the plain answers to the assigned problems. They were also allowed to acquire knowledge outside of either resource.

The five assigned investigative problems were (1) while a cold front is passing through Taiwan, would it be colder in the north than in the south, (2) would a stationary front lingering on the east coast cause heavy rain falls, (3) what the influences of a storm cold front passing through Taiwan on the amount of rain falls in the north and in the south respectively, (4) would the amount of rain falls brought in by 'Spring-rain stationary front' be more than that brought in by 'Mei-yu stationary front', (5) after a cold front passed through, would the temperature in high mountains be lower than that on the level ground. While the three expert groups were scaffolding knowledge on (1) climatic factors, (2) weather map, (3) high altitude atmospheric exploration, respectively.

4.2 Procedure

The complete network-based learning program ran through a 2-week period. The learners in the study were instructed to follow the curriculum set for each team and the instructions were supplemented with on-line 'tour-guide'. Before the learning program took place, the students were gathered on one-day workshop on operational knowledge. They were tutored on concept map, PBL model, the usage of database of primary sources, the know how about getting on-line and to participate in the GeoSchool network-based learning environment. Returning home from the first day gathering, the learners did not meet face-to-face in the following 14 days except on the web in their respective team area in GeoSchool. The mentors worked with the learners every day on the web. After the conclusion of their problem assignment, all the participants did meet at the last day of the program to reflect and share their experiences through this network-based learning program.

4.3 Data collection and analysis

We used a portfolio of artifacts including assignments, concept maps, reports, and posted articles to create the study on how the learners engaged in the social discourse during the network-based learning period. Each learner's posted articles were recorded by the web-BBS/DNEWS system in the GeoSchool environment for analysis.

Data were analyzed in several phases. First, DNEWS record file was transformed into Excel format and the posted articles were displayed in table format. Then, the nature and contents of each article was analyzed and the columns of qualitative descriptors in the table were checked as the classification of this article. In addition to the categorization of the articles according to their nature and contents, the insight of the social discourse were also looked into in order to discover the characteristics of (1) the interaction between mentors and learners, as well as among learners, (2) the initiation and diminishing of the threads in the social discourse, particularly threads with questions included that sustained more than 5 thematic discussions (re-posts), and (3) the correlation between style and responses.

4.4 RESULTS

The results are presented here in five parts. They are the statistics of the classification of the articles posted by the learners and the mentors, the content properties of the social discourse and the questions raised in the posting, and the effectiveness of the scaffolding strategies applied by the mentors.

4.4.1 The Classification of the Articles Posted by the Learners and the Mentors

Table 1. Classification of Articles Posted by Learners

No.	Category	Frequency	Percentage
3	Social interaction	906	38.5
6	Content knowledge	628	26.7
7	Group progress & self-regulation	499	21.1
1	Network	123	5.2
4	Database of primary sources	103	4.4

BEST COPY AVAILABLE

2	PBL model	66	2.8
5	Methodology in science	31	1.3
Total		2356	100.0

Table 2. Classification of Articles posted by Mentors

No.	Category	Frequency	Percentage
6	Content knowledge	136	32.9
2	PBL model	64	15.5
3	Social interaction	55	13.3
1	Network	53	12.8
5	Methodology in science	48	11.6
7	Reinforcement	39	9.4
4	Database of primary sources	18	4.4
Total		413	100.0

The statistics of the attributes of the articles posted by the learners and the mentors are shown in table 1 and 2. The categories 1 to 6 in the classification are the same in both groups, while the 7th category is 《Group progress & self-regulation》 for the learners and 《Reinforcement》 for the mentors. Apparently, social interaction is the most important discourse for high school students on the web. Articles on 《Content knowledge》 and 《Group progress & self-regulation》 ranked the second and the third, which implies that the learners are diligent and motivated and the problem assignments were challenging to domain knowledge. The low ranking of mentors' effort on 《Reinforcement》 also verifies this derivation because it did not seem necessary. The mentors were by no means parsimonious in offering encouragements.

In contrast, mentors spent more time in prompting on the 《PBL model》 in addition to content knowledge, whereas the learners didn't care too much about it. The issues on 《methodology in science》 were the least brought up actually revealed its unfamiliarity to the high school students. They were generally insensitive to the methodology issues. However, the low frequencies on 《Network》 and 《Database of primary sources》 seemed to reflect the learners' proficiency in accessing network and the CD database of the primary content knowledge sources. The GeoSchool user interface was friendly and the one-day workshop on the operational skills at the beginning was effective.

4.4.2 The Threads

Table 3. The Distribution of Elicited Discourse Threads

No.	Category	# of Threads	Percentage of Threads	Total posted articles
3	Social interaction	60	37.3	494
6	Content knowledge	59	36.6	573
7	Group progress & self-regulation	26	16.1	172
1	Network	9	5.6	52
2	PBL model	4	2.5	36
4	Database of primary sources	2	1.2	13
5	Methodology in science	1	0.6	6
Total		161	100.0	1346

In order to explore what kind of interactions the learners were interested in, we traced the part of discourse that are sustained more than 5 round of responses. The ranking of the categories of threads is almost the same as the classification of the learners' articles as shown in Table 1. These threads covered 1346 articles, which is 50.1 % of the total. An average of 8.3 posted articles per thread were categorized across the seven categories as shown in Table 3.

4.4.3 The Questions Raised

Table 4. The Distribution of the Questions Raised

No.	Category	Frequency	Percentage
6	Content knowledge	196	37.4
7	Group progress & self-regulation	141	26.9
3	Social interaction	114	21.8
1	Network	28	5.3
4	Database of primary sources	17	3.2
2	PBL model	15	2.9
5	Methodology in science	13	2.5
Total		524	100.0

The biggest category of the questions raised is 《content knowledge》. It appears that the learners were involved in the justification of their own responses or in the evaluation of other's responses while operate in a self-prompting dialogic mode. The second biggest category of the questions raised, 《Group progress & self-regulation》, is referred to plan, monitor, and evaluate progress, divide responsibilities, manage procedures and affect as well as task completion. It seems that the network-based environment provide a convenient channel for coordination. The third biggest category 《Social interaction》 reveals needs of interaction and entertainment on learning which were not allowed and encouraged in traditional classroom environment.

4.4.4 Strategies Mentors Applied with Effect

Table 5. The Strategies Applied by Mentors in Scaffolding 《Content Knowledge》

Item	Strategy	Frequency	Percentage
H	Answer directly	43	37.4
A	Ask back	25	21.7
E	Suggestions & hints	16	13.9
C	Remind their prior experience	10	8.7
G	Pretend to be a peer learner	6	5.2
D	Give examples & draw an analogy	6	5.2
B	Ask question back to create a conflicting situation	5	4.3
F	Illustrate terminology	4	3.5
Total		115	100.0

Among 342 articles posted by the mentors, 223 (65.2%) were justified to be helpful. Table 5 shows the strategies with effect applied by mentors in scaffolding discourse of category 《Content Knowledge》. Not surprisingly, the guided prompts that with significant effects were 《Answer directly》, while 《Give examples & Draw an analogy》 and 《Ask question back to create a conflicting situation》 were less worked.

5 DISCUSSION

Although there have been some insightful studies examining collaborative learning in science (Coleman, 1998; Edelson, Gordin, & Pea, 1999; Krajcik, et.al.,1998; Lin, et.al., 1999), few have attempted to investigate whether the formation of network-based learning community will promote learners' reflective practice or ability of inquiry. This study sought to document a rich description of the social discourse under the Geoschool environment in order to understand the impact of a network-based environment on social discourse in science learning. Following issues deserve further discussions on the interpretation of out results.

5.1 The interpretation of the percentage of the categories.

One of the purposes we classify learners' posted articles into categories is to discover the characteristics of the learner's interactive process and the behavior pattern of the inquiry based learning of high school students.

At the beginning of the study, we thought the percentage of each category represented the importance of it. We found that the three largest categories collectively accounted for almost 86% of all posted articles categorized. The rests were on 《Network》, the 《Database of primary sources》, the 《PBL model》, and the 《Methodology in science》. They were fairly evenly distributed over the remaining smaller categories.

However, cross-referenced by other artifacts, we realized that inquiry did pose many challenges for learners. Among the challenges, the use of the database of primary sources and the familiarity of inquiry skills are the most difficult ones. In short, being small does not mean that the smallest categories can be ignored. On the other hand, the smallest percentages should be interpreted as the reflection of learners' limited experience and inability to elicit discussions.

5.2 The effects of discourse with mentors

The effects of mentor's role in the social discourse of learning can be further elaborated in the following ways:

First, the existence of mentors has impacts on learners' motivation. One learner wrote: "We've got to think of some insightful questions to ask the mentor, otherwise our group would be looked down upon by her (group E #120)." Reflecting on and articulating explanations on the web, from one perspective, is much the same as that in front of others. That places the inquiry on the table and leaves it open to evaluation and criticism. This is a characteristic of the discourse in the network-based community.

Second, the mentors in the social discourse present a sense of certainty and authority for the learners. One learner wrote: "I just transformed data into a figure. I would like to share the finding with you. I'm afraid that you would think that I'm an idiot because my score on Earth Science is B at school. The finding might be just wrong. I'm looking forward to your comments (group E #551)."

Third, reinforcement is another effect the mentors can have on the learners. Different from the scaffolding provided by technology, mentors are sensitive to the quality of inquiry and can be more encouraging to the learners.

5.3 The unhelpful scaffolding Styles

Sustained inquiry should be a key element in science learning. There are several styles of scaffolds that proved to be ineffective.

First of all, the responses with scandal connotation would be of absolutely no help. One mentor wrote: "hello, hello, I don't think you are the kind of people who accepts others' opinion without reasons. ... Pick your brain, otherwise it will gather spider web.

Besides, some mentors are very enthusiastic in helping learners whenever they got stuck. One mentor wrote: "I am so impressed by you guys' sustained discussion. I can't help but prompting something. … Try to think about … Then how about ...Why not..." The pattern described above is to raise several questions continually. The effect of this kind of scaffold is usually followed up by no further response. The reason for such a failure can be seen from at least two aspects. On one hand, the learners usually doesn't like to answer so many questions at once; on the other hand, the mentor provides the prompt at a time when learners are not in need. Therefore no further discussion would emerge. Many threads were ended up with mentor's big talk, which didn't facilitate the inquiry process but in effect killed it.

Interestingly, in the category of 《Reinforcement》, we can also find some unhelpful scaffolds. For some aggressive mentors, affirmative comments quite often followed by mentor's expectation of higher-order inquiry skills on learners. For example, the learner might be asked to provide further justification or reconcile what they know and do not know. This kind of reinforcing style also threatens the learners.

5.4 When does the meaningful learning occur?

It is difficult for the mentors to realize when was it appropriate to offer a prompt. The answer can be found by examining what these learners were actually doing during their natural unguided discussions. We found that later intervention is better than earlier intervention. However, with no intervention at all, the peer learners might encounter difficulties accepting one another's point of view and might not be able to overcome conflicts before giving up. The excerpts below are two learners' discourse in such a case (group D#342-347).

> Learner A: Let's propose hypothesis#3 as "Both 'Spring-rain stationary front' and 'Mei-yu stationary front' cause weak upward convective motion.".
>
> Learner B: I think this hypothesis should be modified as "'Spring-rain stationary front' causes strong upward convection; while 'Mei-yu stationary front' causes weak convection." What do you think?
>
> Learner A: Why?
>
> Learner B: It makes more sense from what I know.
>
> Learner A: We can still stick to the original one and continue with the derivation. If the final result turns out to be wrong, we could just overthrow the hypothesis later on.
>
> Learner B: No comments ... Shouldn't we make assumptions with as much sense as possible instead of groundless wild guesses?

6 CONCLUSIONS

As a tailpiece, it is worth commenting on the analysis of posted articles on the web. To explore the authentic interactive process of learners, we classified 2865 posted articles. It was a time-consuming task. However, it was this process of classification that uncovered the underlying interactive dynamics among the members of the network-based learning community.

Apparently, the influences of social discourse on science learning were multi-faceted. In the social discourse, the learners' were motivated, timely encouragements were provided; scaffolding was also facilitated for their understanding of content knowledge. However, inappropriate scaffolding styles could turn into just the opposite.

The percentages of the social discourse in the categories reflect the learners' initiation on aspects of learning activity, however, they do not imply the importance of the categories in the learning process. Low percentage of a category could be caused by the difficulties of inquiry skills and reflective practice encountered by the learners in the discourse. Therefore, a comparison of different group dynamics warrants further study.

ACKNOWLEDGEMENTS

This work has been supported by the National Science Counsel under the Grant NSC 88-2511-S-008-002 and NSC 88-2511-S-008-006. We owe our sincere acknowledgement to all the researchers, participating teachers, and research assistants in the GeoSchool Project for their crucial contributions. Finally, we owe a special thanks to Professor Tse-Liang Yeh, who continually and willingly gave his time to view the manuscript and provided us with his expertise, advice, questions, and support.

References

[1]Coleman, E.B. (1998).Using explanatory knowledge during collaborative problem solving in science. *Journal of the Learning Science*, 7(3&4), 387-427.

[2]Edelson, D.C., Gordin, D.N. & Pea, R.D. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *Journal of the Learning Sciences*, 8(3&4), 391-450

[3]Kagan, S. (1994). *Cooperative Learning*. CA: Resources for Teachers, Inc.

[4]Krajcik, J.,Blumenfeld, P.C., Marx, R.W., Bass, K.M., Fredricks, J, & Soloway, E. (1998). Inquiry in project-based Science classrooms: initial attempts by middle school students. *Journal of the Learning Sciences*, 7(3&4), 313-350.

[5]Lin, X., Hmelo, C., Kinzer, C.K., & Secules, T.J. (1999). Designing technology to support reflection. *Educational Technology Research & Development*, 47(3), 1042-1629.

The Application of Scaffolding Theory on the Elemental School Acid –Basic Chemistry Web

***Zangyuan Own, Kai-Pein Wong**
Department of Applied Chemistry, Providence University
#200, Chun-Chi Road, Shalu, Taichung, Taiwan 433
Tel: +886-4-6329216
Fax: +886-4-6327554
E-mail:zyown@pu.edu.tw

The knowledge of chemistry is base on the realization of fact and experiments, students must try to infer, experiment and realize deeply to achieve the goal of highly efficient learning. Base on the scaffolding theory, we have designed a three- tier client-server web title which is a distributional database formats about the chemistry subject-"Acid and Base chemistry" for elemental school students. We use a lot of multimedia animation and Internet techniques to create a scaffolding environment make students learn it instantly and mutually. It turn out that all the students have excellent improvement learning outcomes. All the experts, the interaction designing experts, the network experts, software designers and primary school teachers gave a positive affirmation about the web title; the teaching content and the interaction design are all get the very positive confirmation. The result of learning effect is very convention; the statistical analysis shows that all learners who entered this web site made a great progress in their knowledge test. Besides, ANOVA statistical analysis shows that this scaffolding chemistry web site made a great help for L type learners. Learners' previous science knowledge has nothing to do with the study effect.

Keywords: **Scaffolding Theory• •Acid-Base Chemistry• •Web Title and Learning Effect**

1 Introduction

Because of the shortage of real experience and the misconception of teaching content, traditional teaching cannot inform the students about the concepts which teachers want to deliver. With the development of the Internet, the form of education is shifted from teacher center to the learner center. The future of science teaching is base on the new nine-year consistent project, it is important to integrate the Internet as a major tool to enforce this project. All of these will help improve the quality in elemental chemistry education for our children.

2 Motive and purpose

In these coming years, internet was the major domain of research academics and government officials. In the 1990s Internet software took giant leaps forward in usability. The biggest change came with the development of the World Wide Web (WWW), a vast tract of the Internet accessible to just about anyone who could point to buttons on a computer screen. It led the Internet's transformation from a text-only environment into a multimedia landscape incorporating pictures, animation, sounds, and even video.

The teaching by the Internet exceeds the traditional passive one-way learning, but stresses on interaction. Taking the advantage of instant pass by the Internet, you can browse through all kinds of fascinating information sources and discover worlds of knowledge. We create a web page about the chemical experiments- the acid and base in nature environment. By the global of networks, we can easily transform the information by character, animation and video. The different learning effect which associated with different learning style students, different ages, different sex and different previous knowledge of science may cause the different learning out come.

3 Theory background

The scaffolding theory brought up by a Russian psychologist (L. S. Vygotsky). He sustains students with the scaffolding techniques through out his teaching process. In the beginning of the scaffolding, it would be a process from other-regulation develops to social negotiation. In teaching, the teacher will design a temporary supporting constructions thought out the whole lecture, which help the learner to develop his learning ability. It is called scaffolding. There are two important subjects within the scaffolding theory. There are communication and cognition, the function of social cognition is to make the learners improve his abilities in solution and self-examination, and students certainly be promoted by the active learning styles.

Scaffolding instruction means that the teacher can help the learner make the most of their potential. Under scaffolding instruction, student will join the learning activity positively instead of remaining passive. Thus, an individual would have his own cognition framework.

There would be six important principles about the instruction.

1.In the real teaching activity, the teacher is the scaffolding maker for the learner.
2.The supporting degree is dependent on the standard of the learners; there would be a modification.
3.The more the ability of the learner increases, the less the support decreases.
4.The support is in proportion to the standard of the activity.
5.The suppor will be modified gradually and at any time. Then it would keep on.
6.Make the learner independent.

In the learning effect, many scholars announce their research results. They would analyzed what kind of the learner is and then decide to create the appropriate on-line instruction web page. Different learning-styled students in CAI(Computer-assisted instruction) would have different learning effects in various feedback.

The feedback is composed of the following four parts:
No feedback. (2) Knowledge of results feedback. (3) Informative feedback. (4) Informative feedback in personal language.

According to the research results by the scholars Dori and Yohim(1990), students in proper sequence may have highly-efficient learning effects. On the contrary, learning by leaping ways was low efficient learning effect. The former is called L type, and the latter is called W type. It means that different learning style may cause various learning effects to students.

The learning ways of students are classified into Super-L, L, W and Super-W type. There are large parts of high school students with L type in particular. The second position is W type. The L type (straight-line) means students follow the learning materials and never change the route. The W type means students don't follow the learning materials and change the route all the time. The Super-W type means that students may play out the entire learning process. It has a strong relation between the learning style and the logical thinking talent.

4 The Research Method

System Installation

The research is base on a web title course, it is a Three-Tier Client-Server sets. Most browsers accepted this kind of device. Server can share responsibility for the management to the request of client. It can transform the information from the database by the request of the client, then the client will process the information it got from the server.

To achieve harmony with education, the government has computerized all elemental schools, but the schools have not been equipped with highly-performance computer. Microsoft bring up an idea of thin client. A computer with modem and browser can use this system. To have a better web title designed, we got the type called 3-Tier (Figure 1). It bases on the platform of Windows NT 4.0 Server SP6. We created the Web Server with Microsoft Internet Information Server 4.0. As a result of dealing with the users' get-in information, we use the MS-SQL 7.0 Server system as a platform for database.

In the process of making the web site, we use a computer with Pentium III 450 processor, which is associated with Front page 2000 to design all the required homepages. And we use the common draft tools (Adobe Photoshop and Macromedia Flash) to deal with pictures and make them more interactive. Finally, we use the SPSS statistics system to analyze the results of learning effect.

The part of system interface, we use ASP(Active Sever Page) to design the interface, and take the advantage of Visual C^{++} to create a stable and efficient web page in the core part .

5 The Research Object

Our research is aimed at the students in Grade Six of elemental school. The design for course content

We take a lot of real household materials, which is concern about acid and base as teaching examples. Such as the lemon• Clorox and vinegar. The nature of soap water is slippery. If you wet your clothes carelessly with sulfuric acid• hydrochloric acid or sodium hydroxide, the clothes would be damaged. And they will scorch the skin. There would be the calculation of the PH. The definition of acid and base is on the produced amount of H^+ and OH^-.

The vinegar is composed of five percent of acetic acid. The molecular formula of acetic acid is written as CH_3COOH. The one hundred percent of acetic acid is called icy acetic acid. The reason why a lemon has acidity is that it is composed of lemon acid.

In the laboratory, the ammonia NH_3 is a base. It is because it produces a lot of OH^- in water. The ammonium ion is acid. It is composed of H^+. At the normal temperature, the HCl is gaseous state. It is a acid. The carbonic acid H_2CO_3, Sulfuric acid H_2SO_4, boric acid is all acids. There are common base such as sodium hydroxide NaOH and calcium hydroxide $Ca(OH)_2$. Sodium bicarbonate $NaHCO_3$ is a base; it has a common name called baking soda. People with much hydrochloric acid in gastric juice may take some medicine composed of magnesium hydroxide to neutralize.

The experts and scholars suggest that we should create a interactive web page of scaffolding theory should base on the acid-base knowledge map which is created at beginning of the course. The another major frame is an on-line discussion section. Initially we would have some general questions about acid & base, which the students have to find out their own solutions. If their answer is correct, then they can enter another subject, otherwise they have to keep on finding the answers. In the process of learning, students may have an efficient learning freedom by the active video program we provide with in the web page.

The content of the web
1.Question-learning function induce students to learn.2.Question of situation in our daily life.3.A simple operation interface.4.To stress on vision and hearing.5.Guided learning then learning control.

There are twelve units in the teaching material, which is a scaffolding design.
1.Litmus paper. 2.The nature of liquid.3.The definition of alkaline-liquid operation.4.The definition of acidic-liquid operation.5.The definition of neutral-liquid operation.6.The reaction between alkaline and acidic liquid.7.The neutralization of acid and alkali.8.The application of neutralization of acid and alkali.9.The nature of acid and alkali.10.The nature of sodium hydroxide.11.The advanced concept of acid.12.The advanced concept of alkali.

Most of elemental school students cannot understand the nature of acid and base. So we classify the course into two parts, which may happen in real life and in the textbook. We ask the student to register as they entering the studying web page. And let them brow though the entire house, which have five areas (kitchen, bathroom, living room, backyard and bedroom), all fill of the brand name items. The computer will record the pass way of learner, which then will be analysis to learning style (W-type or L-type). If the learner follow every step of the computer, they will have 10 points, which is classify as L-type, if the learner did not follow the step which computer direct, they will deduct 2 point for each time, the points lower than 3, it is classify as W-type. The acid-base lecture is designed base on scaffolding theory. The system would determine when to removes the scaffolding setup or not by the amount of the correct analysis of computer generated data and suggestion by the experts and the scholars. After a serious study, this system is set up to remove the scaffolding structure when students scored seventy percent of designed questions. Before the system removes the scaffolding structure, the on-line instructor is standing by the side to help them solve some difficult problems. It's so-called on line ICQ.

For example, if students ask what the hydrochloric acid is by the on line ICQ. The instructor will pub out and tell the student that it's a kind of corrosive solution, which is used to clean your bathroom

The hydrochloric acid also exists in our stomach; it helps us in the digest. You can clean the lavatories in the schools or in our home with it, too. And all of these questions and answers will be put into Acess database as a Q&A databank for future use.

If the scaffolding has been removed, a discussion section will appear on the screen. Students can ask any question or play the teacher part to answer questions. We can save lots of the teaching resource in the way.

All the pretest and posttest questions are substrate from ACS (American Chemical Society) test bank, which is careful designed and tested for, determine chemistry knowledge of students.

6 Result and Discussion.

From January 10 to March 10 we have selected 221 students to analyze. And the result of analysis is as follow (table 1):

Table 1. The analytic table about the learning style

Category	Amount	Average	Standard varies
Boy	118	5.65	1.13
Girl	103	5.81	2.08
Whole	221	5.72	1.57

Research Sample

There are 221 students enter our web site for learning acid and base concepts, base on their data collected, we picked up forty learners (twenty are L-type, twenty are W-type) as our study samples. L-type (Boys >7.78, Girls>7.89) and W-type (Boys < 3.52, Girls<2.73)

Evaluate the Web Site

We invited five elemental school science teachers, five teaching scholars, five software designers, and ten elemental school students to evaluate the web site. The average results are in table 2.

Table 2. Statistic of evaluation result

Item	Software designers	Teaching scholars	Elemental teachers	Elemental students
Homepage design	4.50(90%)	4.50(90%)	3.75(75%)	4.50(90%)
Teaching material	3.75(75%)	4.25(85%)	4.75(90%)	4.10(83%)
Interface	4.30(86%)	3.90(78%)	3.60(85%)	4.70(94%)
Whole style	4.25(85%)	4.25(85%)	4.50(90%)	4.50(95%)

In the aspect of homepage design, elemental schoolteachers gave us lower points (3.75). They thought that instructional contents should be more intensive, and the relation knowledge should increase to enrich our web site. The software designers thought that the homepage should be more vivid than previous to stress the topics.

In the aspect of teaching material, some students complain that contents are not obvious, and we should introduce topics clearly.

In the aspect of interface, the teaching scholars and software designers thought that the operation should be familiar with users. In the meanwhile, they generally praised us in animation, and encouraged us used more.

At whole aspect, they all thought that web base learning indeed archiving the instruction targets.
Learning Effect

After tested, all eighty students had been improved in their acid & base knowledge. The overall improved score average is 18.15. L-type learners average improved 23.35, and W-type learners average improved 12.95 (table 3). It is obvious that our web site have much help in learning acid-base chemistry.

Table 3. The statistics of achievement test

L-type	Pretest	Posttest	Improved	W-type	Pretest	Posttest	Improved
Average	55.80	79.15	23.35	Average	51.75	64.70	12.95

We used the SPSS statistics software running data to analysis the deviation. The P value of learning style relation to score of pretest is 0.063, which is greater than 0.05, indicated that the learning style has no relationship to the pretest score. (table 4)

Table 4. Deviation analysis of different learning style relate to pretest score

Deviation source	Degree of free	Average square root	F	P
Learning style	1	529.256	3.499	0.063
Inaccuracy	158	151.258		
Total	159			

The P value of learning style relation to the score of posttest was 0.015, which was smaller than 0.05. It indicate that posttest score was relation to learning style, which means that L-type learning style improved remarkable. (table 5)

Table 5. Deviation analysis of different learning style relate to posttest score

Deviation source	Degree of free	Average square root	F	P
Learning style	1	1829.256	5.993	0.015
Inaccuracy	158	305.240		
Total	159			

7 Conclusion

Instruction by Internet is the better way in teaching chemistry at present day. According to our research, we have three conclusions:

1. After using the web site, the learners all had improved their test score remarkably. It shows that it is a better learning process for students to study acid-base chemistry in the elemental school.
2. The P value of learning style relation to posttest score was 0.015, which was smaller than 0.05. It shows that L-type learner had positive progressed in using scaffolding web site.
3. After the experts evaluated the web title, this acid-base chemistry web indeed bringing on-line instruction into full play. This web site's design style could be a very good example for the future science web sites.

Reference

[1] Daonian Liu, L.J.W, David W;"*Delivering a Chemistry Course over the Internet*", Journal of Chemical Education ;Vol.75 No.1 January 1998.

[2] Chris M, Mohammed J N, Penny J G; "*Web-based technology in a constructivist community of learners*", British Journal of Educational Technology, Vol 30 No 1 1999 pp.65-68.

[3] K. A Burke, Thomas J. G, Mark A. W; "*Developing and Using Conceptual Computer Animations for Chemistry Instruction*" ,Journal of Chemical Education., Vol. 75 No. 12 December 1998.

[4] Ned H. M; "*Integration of Computational Chemistry into the Chemistry Curriculum*",Journal of Chemical Education", Vol. 75 No.2 February 1998.

[5] Richard D. M; "*Chemistry on the Web*", Journal of Chemical Education; Vol 73 No.1 January 1996.

[6] Willian J. T, Jr; "*The Multimedia Chemistry Laboratory: Perception and Performance*", Journal of Chemical Education; Vol 73 No.9 September 1996.

The Design and Implementation of Automatic Exercise Generator with Tagged Documents based on the Intelligence of Students:AEGIS

Tsunenori Mine Akira Suganuma Takayoshi Shoudai
Graduate School of Information Science and Electrical Engineering, Kyushu University
6-1 Kasuga-kouen, Kasuga, 816-8580 JAPAN
E-mail:{ mine@is, suga@is, shoudai@i }.kyushu-u.ac.jp

Abstract

Many Internet technologies enable us to hold lectures with Web contents and even develop new lecture methods using the technologies. This paper proposes AEGIS (Automatic Exercise Generator based on the Intelligence of Students) that generates exercises of various levels according to each student's achievement level, marks his/her answers and returns them to him/her. In order to realize this feedback mechanism, we currently restrict the question-types which are generated to the following three types: multiple-choice question, fill-the-gap question, and error-correcting question. All question-types can be generated from the same tagged document. The aim of this system is to help the students understand the lecture with exploiting preexisting electronic documents.

Keywords: Artificial Intelligence in Education, Web-Based Learning, Exercise Generator

1 Introduction

As the Internet has come into wide use, WWW environments provide lots of opportunities to various fields. In the educational domain, Web data are being exploited as useful materials. We have been developing Web-based self-teaching systems and building the tools for helping students understand their subjects[1, 2, 3, 4].

We are currently focusing on the automatic student's achievement level evaluator that generates an exercise from tagged documents, presents it to students and marks their answer automatically. We call the system AEGIS (Automatic Exercise Generator based on the Intelligence of Students)[6, 7].

Creating exercises which are suitable for students is not easy. When we try to make some exercises for them in classes, we have to take at least their achievement level into considerations. The well-considered exercises are useful not only to measure the achievement level of students but also to improve their performance. It is not easy task for any teacher to make exercises of various difficulties according to their achievement level. Besides, it is very important to mark the students' answers and return the marked results to them for keeping their learning enthusiasms. This task becomes harder in proportion to the number of the students in a class[5].

This paper discusses AEGIS, which generates the three question-types from the same tagged data. Guessing the achievement level of each student from his/her trial history, AEGIS selects the most suitable question-type and exercise for him/her according to not only his/her achievement level but also the difficulty of the tagged data. After marking his/her answer, AEGIS returns it to him/her with its explanation.

The aim of this system is to exploit pre-existing electronic documents, in particular, our on-line documents shown at our Web site (http://cl.is.kyushu-u.ac.jp/Literacy) and to help students understand their lecture whose materials are set up as Web data so that they even at home can try exercises using AEGIS through the Internet.

The rest of this paper is constructed as follows: Section 2 shows related works to discuss the difference from AEGIS. Section 3 describes question-types that AEGIS deals with, considering both view points of students(answerers) and teachers(questioners) and Section 4 describes the exercise generating process by AEGIS. Section 5 shows the overview of AEGIS.

2 Related Works

A lot of automatic quiz generators have been proposed so far. Browning et. al. proposed Tutorial Mark-up Language(TML in short) to generate questions automatically[8, 9]. TML has a couple of tags to specify a question, a multiple-choice and a message. It requires a correct answer in a multiple-choice tag to mark a student's answer to the question. Carbone et. al. proposed CADAL Quiz[10], which generates a multiple-choice quiz from a question database. After marking a student's answer, CADAL Quiz returns the result to him/her and tutors. Both of them restrict the question type only to a multiple-choice quiz. On the other hand, ClassBuilder[11] generates many kinds of quizzes and grades a student's answer. However, all of them do not mention any effect of making the difficulty level of question-type change according to the students' achievement level. In order to improve their performance and keep their enthusiasm to challenge the quiz for a long time, it is indispensable to consider their performance level for generating their exercise. This point is the difference from other systems. AEGIS makes use of pre-existing electronic documents so as to embed tags into them, generates exercises automatically with tagged documents according to students' achievment levels, and reestimates both their levels and the difficulty level of the generated question through marking their answers.

3 Question-Types

There can be several types of a question in every subject. Since our aim is to get a computer generate an exercise and mark student's answer to it, we thus restrict to the following three question-types: multiple-choice question, fill-the-gap question, and error-correcting question.

Multiple-choice question. Students choose the correct answer from a given candidate list.
Example. Complete the sentence. Choose your answer from the following list.
Data structures need to be studied _____ order to understand the algorithms.
(1) an (2) in (3) on (4) at (5) by

Fill-the-Gap question. Students try to fill in the blank of a given sentence with the correct answer without any help.
Example. Fill in the blank with the right word.
Data structures need to be studied _____ order to understand the algorithms.

Error-correcting question. Students have to find the wrong expression in a given sentence and correct it.
Example. Right or wrong? Correct the sentence if it is wrong.
Data structures need to be studied an order to understand the algorithms.

All of these question-types can be constructed from a sentence by replacing one or more consecutive words with a blank or a wrong expression. We call the region replaced *hidden region*. We note that these three question-types have different difficulties even if they are constructed from the same *hidden region*. Figure 1 shows the tagged data to be used for generating the above three types of questions.

```
⟨QUESTION SUBJECT="idioms"⟩
Data structures need to be studied ⟨DEL CAND="an,on,at,by"⟩ in ⟨/DEL⟩ order to un-
derstand the algorithms.
⟨/QUESTION⟩
```

Figure 1: The tagged data to generate three question-types shown in Section 3

Students' View Point

Every multiple-choice question has surely the correct answer in its candidate list and contains the information that leads students to the correct answer. They can therefore make their choice with confidence from the list. In the case of a fill-the-gap question, they have to fill in the blank by themselves with their convinced answer without any information about the answer. Comparing both question-types, we can say that a fill-the-gap question is more difficult than a multiple-choice one. In the case of an error-correcting question, it forces them to determine whether or not there is an error in the question sentences and to correct it if it is found. An error-correcting question gives no information leading them to its correct answer, and the wrong expression in the sentences is not clear for students. We can therefore say that an error-correcting question is the most difficult one for students among those question-types.

Teachers' View Point

Once teachers set a *hidden region*, the efforts that are required to make with the three question-types are similar. The process for making exercises is as follows: in the case of a fill-the-gap question, the teachers have nothing to do. There is no information that they have to add to the exercise paper. We can say that a fill-the-gap question is the easiest one which is made among these three question-types. In the case of an error-correcting question, teachers have to think of at least one wrong expression which can be replaced with the *hidden region*. In the case of a multiple-choice question, they have to prepare several distractors to construct a candidate list. We can say that a multiple-choice question requires more information than an error-correcting one. From their points of view, a fill-the-gap question is consequently the easiest one which is made, and an error-correcting question is easier than a multiple-choice one.

4 Automatic Exercise Generating

4.1 Exercise Generating Process

The exercise generating process from teaching documents is summarized as follows:

1. Setting a *hidden region*: teachers make clear their intention why they want to ask the question to their students, that is, they consider which of the *hidden regions* is the most suitable for their intention.

2. Selecting a paragraph or sentence(s) from teaching documents: the sentences before and after *hidden regions* are often of importance to ask their students the unique answer of the question. We call the paragraph or sentence(s) a *question region*. A *question region* may have more than one *hidden region*.

3. Constructing a candidate list: a multiple-choice question requires a couple of distractors to set up a list of answer candidates. Any distractor should be natural so as to be added to the list. This list depends on the teacher's intention.

These three steps are deeply related to the teachers' intentions. It is not easy to extract such intentions automatically from the teaching documents. AEGIS system thus deals with tagged documents that already have the information such as *hidden regions* and candidate lists.

4.2 Necessary Information for Generating Exercises

In order to embed the above three kinds of information into the teaching documents, we define the following three tags: QUESTION, DEL, and LABEL.

QUESTION surrounds a *question region*, that is, the statements between ⟨QUESTION⟩ and ⟨/QUESTION⟩ are a *question region*. In the region, there can possibly be some expressions that are related to a *hidden region*. They can be good hints to lead students to the correct answer.

SUBJECT is the unique attribute of QUESTION. Its value stands for the subject or topic of *question region*.

DEL indicates a *hidden region*, which is the word(s) or sentence(s) between ⟨DEL⟩ and ⟨/DEL⟩.

A fill-the-gap question can be generated only by replacing the *hidden region* with a blank.

CAND is one of DEL's attributes. It is used to specify a candidate list.

LABEL has an attribute NAME that specifies a dependency relation with a *hidden region*. The sentence/s surrounded by LABEL tags is/are presented as a reference for the answer of a question, which will be generated with the DEL tag whose REF's value is the same as that of the NAME of the LABEL.

⟨QUESTION SUBJECT="W_S"⟩ *question region* ⟨/QUESTION⟩

W_S ::= word or symbol, where a backslash (\) must be added just before the symbol if it is a comma (,), double quotes ("), or a backslash (\).

⟨DEL CAND="CANDIDATE" LEVEL="PAIR" GROUP="ID" REF="ID"⟩ *hidden region* ⟨/DEL⟩

CANDIDATE ::= W_S | W_S,CANDIDATE

W_S ::= word or symbol, where a backslash (\) must be added just before the symbol if it is a comma (,), double quotes ("), or a backslash (\).

PAIR ::= LOW,HIGH

LOW ::= an integer between 1 and 10

HIGH ::= an integer between 1 and 10

ID ::= keyword

⟨LABEL NAME="ID"⟩ sentences ⟨/LABEL⟩

ID ::= keyword

Figure 2: Tags for exercise generations

4.3 Necessary Information for Adjusting Difficulty Level of Question

The additional three attributes of DEL, which contain the information on the difficulty of solving the exercise, are LEVEL, GROUP, and REF. They specify the difficulty of each *hidden region*, and the connections to other *hidden region*.

LEVEL specifies the difficulty of the exercise to be generated from a *hidden region* itself. The value of this attribute is a pair of integers between 1 and 10. These integers specify the lowest and highest achievement level of the students who can try the exercise. AEGIS system determines whether or not the *hidden region* is worth being transformed into the exercise by comparing the student's achievement level from the both values of LEVEL.

GROUP specifies the dependency relation between *hidden regions* and holds the uniqueness of the correct answer. This GROUP is used to adjust the exercise level. If we want to generate more difficult exercises, all the *hidden regions* that have the same values in GROUP are replaced with blanks or wrong expressions at the same time. On the other hand, for generating easier ones, some of the *hidden regions* in the group are not transformed because those regions help students answer the question as hints.

REF specifies the dependency relation between a *hidden region* and other expressions than the *hidden region*. Both the region and expressions are specified with LABEL. If a *hidden region* is connected to an expression, the value of REF in the *hidden region* is the same as that of NAME in the expression with LABEL.

5 AEGIS system

5.1 Overview of AEGIS

The AEGIS system consists of three databases: *Exercise DB* (**EDB** in short), *User Profile DB* (**UPDB** in short) and *Level Management DB* (**LMDB** in short), and three main database managers: *Exercise Generator* (**EG** in short), *Answer Evaluator* (**AE** in short) and *Level Manager* (**LM** in short). The overview of AEGIS is shown in Fig. 3.

Teaching documents with the tags are compiled into the **EDB** and **LMDB**. All of the *question regions* are indexed sequentially and each *hidden region* is labeled with its own subindex of the index of each *question region*. The level of a *hidden region*, which is deeply related to the level of the question to be generated from the *hidden region*, is stored in the **LMDB** together with the index of the *hidden region*. The level of each *hidden region* in **LMDB** is reexamined regularly. **UPDB** keeps students' trial histories with their current achievement level.

EG and **AE** make communications with the users (students) through Web browsers after being invoked through CGI (Common Gateway Interface).

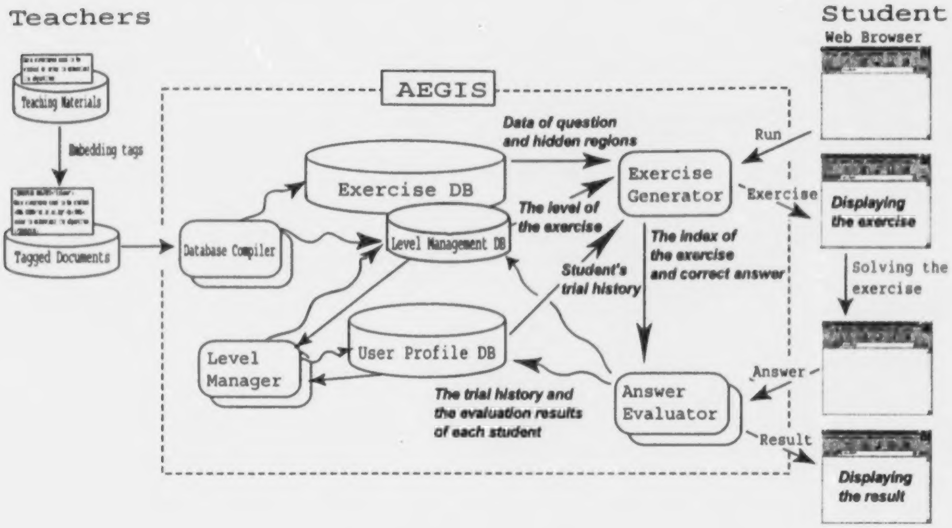

Teachers
Student
Web Browser
Teaching Materials
Embedding tags
Tagged Documents
AEGIS
Database Compiler
Exercise DB
Level Management DB
Level Manager
User Profile DB
Data of question and hidden regions
Exercise Generator
Run
Exercise
Displaying the exercise
The level of the exercise
Student's trial history
The index of the exercise and correct answer
Solving the exercise
Answer
Answer Evaluator
The trial history and the evaluation results of each student
Result
Displaying the result

Figure 3: Overview of AEGIS

5.2 Exercise Generator(EG)

The exercise request from a student invokes **EG**. The **EG** searches the most suitable *hidden region* in **EDB** with looking over both the student's profile stored in **UPDB** and the level of the *hidden region* stored in **LMDB**, and determines the question-type of the *hidden region*. As mentioned in section 3, every question level has a relation to the question-type. **EG**'s decision process of the question-type thus employs the following strategy: If the student's achievement level is closer to the lowest number in LEVEL of the *hidden region*, **EG** selects a multiple-choice question as the question-type with high probability. On the other hand, if it is closer to the highest number in the LEVEL attribute, **EG** selects an error-correcting one.

Once **EG** determines the question-type of the *hidden region*, it is not difficult to generate the question. This is because the *hidden region* represents the correct answer of the question which is generated and teachers have already given the list of distracts explicitly with CAND attribute. Now, let's see how **EG** works when it generates the three kinds of questions:

- *Multiple-choice question*: **EG** randomly constructs one possible list for the multiple choice with both the correct answer and some distracts and outputs a question, which is generated by replacing the *hidden region* with a blank, with the list.
- *Fill-the-Gap question*: **EG** outputs a question which is generated only by replacing the *hidden region* with a blank.
- *Error-correcting question*: **EG** outputs a question which is generated by replacing the *hidden region* with one of the wrong answers specified in the CAND attribute.

Figure 4 shows an example of teaching documents with the tags. It is a piece of the teaching documents in the elementary course of Computer Literacy at our university. This course is taken by all first and second year students, about 2,300 students[5]. The teacher's intention in the example document is to teach how to use multiply and divide operations. Figure 5 shows the three question-types which are generated from the document.

5.3 Answer Evaluator(AE)

After outputting a question to the student, **EG** sends the following three kinds of information to ask **AE** to mark his/her answer: the index of a *hidden region*, the question-type, and the correct answer. After

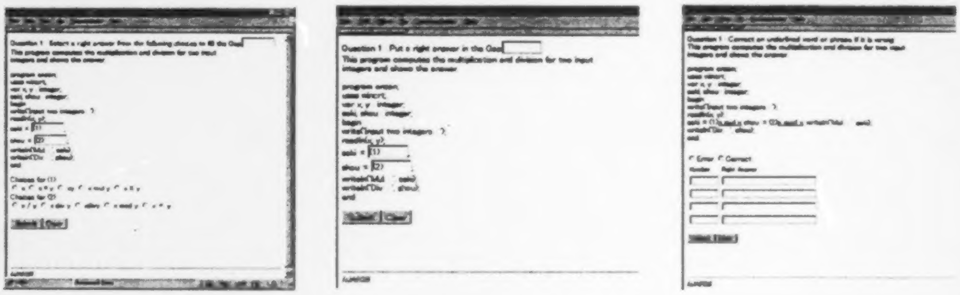
---

In the previous section, we learned a program for adding two integers and showing the answer on the display. In the similar way, for all basic arithmetic operations including addition, subtraction, multiplication, and division, we can make a Pascal program in the following way.
⟨QUESTION SUBJECT="arithmetic operations"⟩
This program computes the multiplication and division for two input integers and shows the answer.

```
program enzan;
var x,y:integer;
   seki,shou:integer;
begin
   write('Input two integers : ');
   readln(x,y);
   seki:=⟨DEL CAND="x,xy,x×y,x mul y" LEVEL="1,5"⟩x*y⟨/DEL⟩;
   shou:=⟨DEL CAND="x/y,x÷y,xdivy,x mod y" LEVEL="1,5"⟩x div y⟨/DEL⟩;
   writeln('Seki:',seki);
   writeln('Shou:',shou)
end
```

⟨/QUESTION⟩
The 7th statement multiplies x by y, and the 8th statement divides x by y. We note that the answer of "div" is an integer.

Figure 4: Example of teaching documents with the tags



(a) Multiple-Choice

(b) Fill-the-Gap

(c) Error-Correcting

Figure 5: Three questions generated from the document in Figure 4

marking his/her answer by matching with the correct answer, **AE** shows him/her the marked result and stores it with the index of the *hidden region* and the question-type into the **UPDB**.

5.4 Level Manager(LM)

Although the initial value of the level of each *hidden region* is specified by teachers, it continues to move up and down according to the students' achievement levels, which will change as time goes by. The supplement manager **LM** processes their achievement levels statistically, computes the revised level of each *hidden region*, and stores it into the **LMDB**. **LM** increases the difficulty level of a question if a student whose level is greater than the level of question answers it wrongly, and decreases if a student whose level is less than the level of question answers it correctly. The new difficulty level of a question is consequently determined as shown in Fig.6.

After updating **LMDB**, **LM** updates the student's achievement level according to the difficulty levels of all questions he/she correctly answered.

Now, we show the formal definition of calculating both the achievement level of a student and the difficulty level of a question. Let $s_{i,t}$ and $q_{j,t}$ be the achievement level of student S_i and the difficulty level of question Q_j at time t respectively, where $1 \leq s_{i,t} \leq 10$,$1 \leq q_{j,t} \leq 10$. $s_{i,t}$ is recursively calculated with $q_{j,t}$ at stated periods and vice versa. They are defined as follows:

BEST COPY AVAILABLE

$$s_{i,t} = \begin{cases} 1 & \text{if } m_{s_i,t} = 0 \\ \frac{1}{m_{s_i,t}} \sum_{j=1}^{m_{s_i,t}} q_{j,t} \cdot \delta_{i,j} & \text{otherwise} \end{cases} \qquad \delta_{i,j} = \begin{cases} 1 & \text{if } S_i \text{ answered } Q_j \text{ correctly} \\ 0 & \text{otherwise} \end{cases}$$

$$q_{j,t} = \begin{cases} q_{j,t-1} + \frac{\sum_{i=1}^{m_{q_j,T}} |s_{i,\tau\in T} - q_{j,t-1}| \xi_{i,j}}{\sum_{i=1}^{m_{q_j,T}} |\xi_{i,j}|} & \text{if } \sum_{i=1}^{m_{q_j,T}} |\xi_{i,j}| \neq 0 \\ q_{j,t-1} & \text{otherwise} \end{cases}$$

$$\xi_{i,j} = \begin{cases} -1 & s_{i,\tau} \text{ is less than } q_{j,t-1} \text{ and } S_i \text{ answered } Q_j \text{ correctly} \\ 1 & s_{i,\tau} \text{ is greater than } q_{j,t-1} \text{ and } S_i \text{ answered } Q_j \text{ wrongly} \\ 0 & \text{Otherwise} \end{cases}$$

Where $m_{s_i,t}$ stands for the number of questions that S_i tried by t and τ is the latest time such that S_i tried to answer Q_j and $t-1 < \tau \leq t$. T is the set of τ. $m_{q_j,T}$ stands for the total number of students who tried Q_j in T. $q_{j,0}$, which is the initial difficulty level of the question Q_j, is given with the attribute $LEVEL$ of DEL tag by teachers.

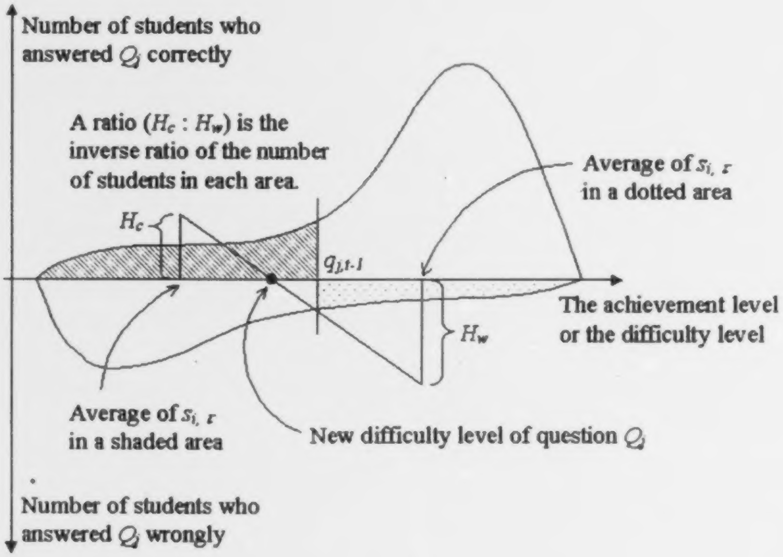

Number of students who answered Q_j correctly
A ratio (H_c : H_w) is the inverse ratio of the number of students in each area.
H_c
$q_{j,t-1}$
Average of $s_{i,\tau}$ in a dotted area
The achievement level or the difficulty level
H_w
Average of $s_{i,\tau}$ in a shaded area
New difficulty level of question Q_j
Number of students who answered Q_j wrongly

Figure 6: Renewing Difficulty level of Question based on Student's Achievement Level

6 Conclusions

We discussed our new Web-aided system AEGIS. The system is currently implemented in Perl scripts and CGI. We have a plan to evaluate this system by applying it to the real courses of Computer Literacy, which are taken by more than 2300 students at our university. We hope it will work fine as an educational tool for every student and help him/her to understand his/her subjects if teachers can make tags in their teaching documents. Also, we plan to implement a tagging tool and an algorithm to generate another kind of exercise that allows more than one correct answers.

Acknowledgments

We thank Dr. Teruko Mitamura at Carnegie Mellon University for her helpful comments to improve this paper.

This research was partly supported by the Grant for Special Academic Research P&P from Kyushu University and the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Encouragement of Young Scientists(A), No. 11780281, 2000.

References

[1] H. Sato, T. Mine, T. Shoudai, H. Arimura, S. Hirokawa: On web visualizing how programs run for teaching 2300 students. In *Proc. Int. Conf. on Computers in Education, ICCE'97*, pages 952–954, 1997.

[2] T. Mine, D. Nagano, K. Baba, T. Shoudai, S. Hirokawa: On-web visualizing a mechanism of a single chip computer for computer literacy courses. In *Proc. Int. Conf. on Computers in Education, ICCE'98*, volume 2, pages 496–499, 1998.

[3] R. Fujimoto, A. Suganuma, T. Mine: Development of a classroom management system on the web. In *Proc. Int. Conf. on Computers in Education, ICCE'99*, volume 2, pages 756–759, 1999.

[4] R. Fujimoto, Y. Tsutsumi, A. Suganuma: Cacce: Computer aided cooperative classroom environment. In *World Conference on Educational Multimedia, Hypermedia & Telecommunications*, page 1686, 1999.

[5] S. Hirokawa, T. Miyahara, T. Mine, T. Shoudai, M. Mori: Teaching 2300 students with www – practice and experience at kyushu university. In *Proc. ERI'96*, pages 59–63, 1996.

[6] T. Shoudai, A. Suganuma, T. Mine: AEGIS: Automatic Exercise Generator with Tagged Documents based on the Intelligence of the Students, Joint Conference on Knowledge-Based Software Engineering, to appear. JCKBSE2000, Brno, Czech Republic, 2000

[7] T. Mine, T. Shoudai, A. Suganuma: Automatic Exercise Generator with Tagged Documents

Considering Learner's Performance Proceedings of WebNet2000, San Antonio, Texas, to appear as a short paper, 2000

[8] P. Browning, J. Williams, D. Brickley, H. Missou: Question Delivery over the Web using TML http://www.ilrt.bris.ac.uk/netquest/liveserver/qbanks/demos/paul/lboro/ohp1.html, CAA, 1997

[9] P. Browning: TUTORIAL MARKUP LANGUAGE - A CBA SYSTEM http://www.soton.ac.uk/~ukgec/workshop/5-cba/minutes.htm#TUTORIAL, 1998.

[10] A. Carbone, P. Schendzielorz: A Web-Based Quiz Generator for Use in Tutorials and Assessment Global J. of Engng. Educ., Vol.I, No.3, 1997 http://www.eng.monash.edu.au/usicee/gjee/vol1no3/paper20.htm.

[11] ClassBuilder GradeBook And Exam Creation Software: http://www.classbuilder.com/

The Design of CAI with Thinking Activity to Progress Constructive Teaching

- An Example of Division-concept in Mathematics of Elementary School

Pou-Yah Wu*, Mei-chueh Shao, Kai-Ren Chen, Ying-Xin Zhong, Ting-Wei Lin and Cheng-Wei pan.
Department of Mathematics Education, National Tainan Teachers' College, Taiwan
**Pou-Yah Wu's e-mail:pywu@ipx.ntntc.edu.tw*

This study aims at establishing a computer assisted learning system of division-concept of networked elementary school mathematics course based on constructivism and stress on students' thinking activities. It explores how students' thinking manifest on network, how the thoughts of the learner and those of the students on-line transfer, and how the thinking of the virtual students' solving problems reflect, so as to develop a set of CAI system about constructive pedagogy. In the system, we provide the learners with diverse tools for thinking activity, letting him/her choose what he/she needs to solve problems. We use network technology to simulate the real learning situation and to make the learner and the user on the line and the virtual students to communicate and discuss immediately. By setting up the CAI system that is compatible with the mathematics education of the elementary school in Taiwan now, we expect the learner to establish the right concepts positively so as to attain constructive pedagogic concept.

Keywords: **Constructive pedagogy; Division of Mathematics; Elementary School; Networked CAI; Thinking Activity.**

1 Introduction

The course design of pedagogy in Taiwan before 1993 is based on objective theory of knowledge. However, the pedagogic design ignores the complex and interactive phenomenon practically. Therefore, mathematics of elementary school in Taiwan in 1993 adopts pedagogic theory of constructivism [6]. Constructive pedagogy improve the shortcomings of the traditional pedagogy; but it also cause the deficiency of pedagogic duration owing to the orders of discussion and reflection in case it is put into practice in the real pedagogic environment. With the popularity of network, provided constructive concepts are applied to the learning environment of network, CAI effect would be promoted further. This study aims to design networked pedagogic environment matching "basic division-concept in mathematics of elementary school" by the learner's thought, using network technology, letting the learner have an environment to learn at home. The traditional CAI system neglects the positive learning and the interaction between the learners. So, we take into how to facilitate the interactive relationship between the system and the learner. Through the transmission of the networked thought, the learners can real-time communicate, making up a whole constructive learning environment, hoping to attain the constructive pedagogic concept.

2 Principles of system establishment

2.1 Basis of learning theory

The pedagogy of constructivism lies in stressing "knowledge is constructed positively by the learner", so that pedagogic design should arrange activities of learning-orientation. In the process of learning, the teacher serves as "problem poser" whereas the students acts as "problem solver"; the teacher plays the role of assistance, and the learner should construct knowledge positively through the interactive discussion between the learners [2]. Each learner utilizes his previous concepts to expound the phenomena around, and then comes up with adjustment or assimilation toward his acquired cognitive structure to establish new concepts. Besides, the learning situation is also an important part of the content, functioning to help the learner to comprehend the differences between the perspective on conceptual traits. Thus, the learning activities ought to provide learners with quasi-actual experimental situation to manipulate, explore. By means of the cognitive conflict brought about by the students in the process of the activity, challenging his original concepts, he/she constructs the right concepts via the discussion and coordination with one another.

2.2 Basis of course content-concept of division

Division is the anti-calculation of multiplication. Both multiplication and division are thought of as the transformation of unity quantity. The so-called "transformation of unity quantity" refers to that using unity quantity as that described by calculating unit, transforming to another description by calculating unit using another unity quantity [1,3]. The situational mode of division question is categorized into two basic principles of including division and even division. Seen from the viewpoints of "transformation of unity quantity" to look at the questions of multiplication- division, the questions of multiplication is to reduce the quantity suggested in the units of higher layers (units accumulated by several units of lower layers) to the activity of transformation from the quantity suggested by units of lower layers; whereas the questions of division "including division" is on the contrary, that is, the quantity suggested by the units of lower layers changed into the transformation activity by the quantity suggested by the units of higher layers. As to even division, it is an activity of new unity quantity of high layers and unknown unity quantity.

2.3 Foundation of system establishment

This system is a learning environment constructed on the network, adopting three-tier client/server system architecture, and meaning adding a layer of service server on the original client-server two-tier client/server system architecture. In the structure of three-tier client/server master-slaver, the part of management of learning data is in the charge of database server, web server takes charge of teaching jobs, while the users of client proceed all kinds of learning activities via browser.

3 Pedagogic design of networked construction

3.1 Pedagogic design of constructive division of new course

The two questions types of division (including division and even division) should be reckoned as different ones, then helping students combine these two types of questions gradually. And by the activity of consecutive subtractions solving questions to communicate with the relationship, then introducing the format of division calculation. Thus, in the design of pedagogy, place the two combined types of characters, letting children solve problems by tangible objects or emblems and try to record the activity of solving questions. After solving the questions including division and even division successfully, try further to grasp the times of distribution including viewpoints of division when confronted with them again [4,5]. The number of unity quantity can be decided by the times of distribution to help students realize and construct the relationship containing two types of questions as to including division and even division. Finally they can introduce the processes of solving questions concerning the methods of many-steps subtraction recording including division and even division and discuss and form the formulas using " ÷ "taking notes of the common sense about the activity of solving questions including division and even division, letting children construct the whole meaningful concept of division.

3.2 CAI pedagogic design of constructive pedagogy by thinking activity

This system emphasizes the spirit of construction to help students establish the concept of division, thereby, expecting the system to become more congenial to the real pedagogic environment. We let the computer become a virtual teacher, besides posing problems, he/she can judge the students' types of solving problems and mode of operation, and providing the dialectics and clarification and discussion undertaken between the users or between the user and the virtual students. Thus, the design of the problems by this system is introduced by the ordinary ones of daily situation to make sure if students have grasped the messages of the problems and communicate and clarify the messages with each other through asking (As in Figure 1). After posing the problems and clarifying the messages, let the students solve the problems. In order to make the system grasp the process of solving problems and thinking, we design "tool table of operation of thinking activity", which contain tangible objects, representation, digits and the symbol of calculations and so on. For example, as shown in Figure 2, if learner choose "to bakery", then the tangible objects can be used to solve the problems. If the learner choose "drawing circles", then representation can be used as the tools of solving the problems (As in Figure 3); if the learner choose "to digital factory", then digits can be used as the tool of operation (As in Figure 4). By the tool of operation chosen by the user, the computer can grasp what he thinks. If the user fails to solve the problems by themselves, they can discuss with others on the line, or discuss by the activity of solving the problems of the virtual students (As in Figure 6and 7) to attain the cooperation and learning. At last, after the user solve the problems successfully, the computer will play the role of the virtual teacher, raising questions to let the user to fortify the concepts, avoiding no continual between the user's order of thought and the concept (As in Figure 5). Then posing problems again to judge the students' learning state in order to proceed another activity dynamically. In doing so gradually, the system expects the learner construct an overall meaningful concept of division.

4 Architecture and implementation of system

4.1 Design environment and tools

This system uses Windows NT server as server platform. The developing languages include HTML, JavaScript, ActiveX, ASP (Active Server page) and so on. Using ASP as the main way of control, and exercising ASP and ODBC (Open Database Connectivity) to go with it, making the user's management of teaching material simplified. In the aspect of editing course software, Authorware5 is a chief developing tool.

4.2 System flowchart

The system flowchart we designs just as Figure 8 shows, the general elucidation is as follows:
1. Pedagogic situation of networked construction: In the beginning, the system would ask the user to register data to set up the database of students' basic data. At the outset of the course, the system will judge the user's competence by the pretest; then according to the basis, the system can pose the problems. After clarifying the messages of the problems, the system lets the user proceed to solve the problems. After solving the problems successfully, it lets the user carry on a series of on-line discussion and communication with the students or virtual students. Based on the acquired knowledge, the students construct the concepts, and fortify or revise the concepts through the experience of reflection. Again, the system poses the problems to judge the students' learning situation, then it proceeds the next teaching activity.
2. Database of "student model": It consists mainly of three databases:
(1) Database of students' basic data: It is used to record the students' basic data such as name, age, the experience of using the computer and so on.
(2) Database of learning: It is used to record the course units the students have learned, the learning state and duration of each unit, and the students' learning results and so forth.
(3) Database of learning achievement: It records the students' assessment about answering and the mode of students' operation.
3. Database of "posing problems of constructive pedagogy": It stores the material content of division pedagogy. The content contains two types of division problems (including division and even division) and various types of processes pedagogic activities.
4. Database of problems: It stores the problems for pretests and posttests.

4.3 Function of on-line communication

Because the system aims at establishing a more compatible with the learning environment of real pedagogy, so that this system design a series of communicative mechanism on the line to help students proceed the learning activities to produce the learning effect. The details will be narrated as follows:
1. Group of discussion: It is an open but not synchronized function on the line. Once the user encounters the learning difficulty, he/she can put the problems on the discussion place, and when other users see them, they can put forth the ways of solving these problems.
2. Room for discussion: It is an open and synchronization for communication. This on-line unction can improve the fact that the single CAI system fails to undertake the defects of communication and discussion immediately. Take Figure9 for example, the user in the room for discussion can carry on the mutual discussion, communication to solve the problems with other users on the line for their learning difficulty.
3. On-Line call: This is a one-to-one synchronous communication way, enabling the learners to proceed one-to-one discussion and forward the brief introduction to other users on the line.

4.4 Operation flowchart for User

When the user enter the system by using browser for the first time, the system would demand the user to register, thereby getting the user's data to set up student model basic data for database, and letting the user accept the pretest to judge the user's level of operation, and recording the user's answering situation. Utilizing the user's answer for reference, modifying the connection dynamically, letting the user connect the courses properly. Afterwards, whenever the user enters the system, he has to register user name and password as the recognition. The system then will proceed next activity according to the user's previous record. When the user undertakes the learning activity, the system will take down the learning state each time, so as to analyze if the user's learning state will attain the expected aim and will be used as learning analysis.

5 Conclusions

With the approach of eased network age, the network will definitely become the trend. Thus, establishing CAI system on the network cannot be delayed. In the light of these, we hope the constructive pedagogy combine with network to make up for the deficiency of pedagogy, letting the learners have more learning space, so as to acquire the real mathematics concepts. This study proceeds to test by the pedagogic content of "division-concept" of elementary school, presently testing all the functions provided by the system, hoping to reassess pedagogic content and system in many months, looking forward to reaching the learners' interaction, fulfilling the pedagogic concept indeed, letting children construct whole mathematics concept.

References

[1] 甯自強, "單位量的變換(一):正整數乘除法運思的啓蒙", 教師之友, Vol. 34, No 1, pp. 27-34, (1993).

[2] 甯自強, "國小數學科新課程的精神及改革動向—由建構主義的觀點來看—", 科學教育學刊, Vol. 1, No 1, pp. 101-108. (1993).

[3] 甯自強, "單位量的變換(二)", 教師之友, Vol. 36, No. 5, pp. 35-44, (1995).

[4] 楊瑞智, "國民小學數學新課程中年級除法教材的設計"八十二學年度數學教育研討會,嘉義,台灣,pp.119-136(1993).

[5] 楊瑞智, "國民小學實驗課程整數乘除算則的教材處理",八十六學年度數學教育研討會,嘉義,台灣 pp.98-113(1997).

[6] 蘇育任, "建構主義式教育的迷思與省思", 國民教育集刊, No. 5, pp. 121-139, (1997).

[7] 吳博雅, 王偉仲, 謝堅, 曾彥鈞, 陳詩茹, 牛晉媛, "網路建構式電腦輔助教學系統之研究—以國小數學科面積基本概念爲例", 1999 中華民國 CAI 研討會論文發表, pp. 159-165, (1999).

[7] Dalgarno, B. Constructivist Computer Assisted Learning: Theory and Techniques. WWW. 21Oct. 1997. Available: http://services.canberra.edu.au/~barney/articles/ascilite96/paper.htm (1997)

[8] Hiltz, S. R. Teaching in a Virtual Classroom. 1995 *International Conference on Computer Assisted Instruction ICCAI'95* Hsincku, Taiwan http://it.njit.edu/njIT/Department/CCC/VC/Papers/Teaching.htm

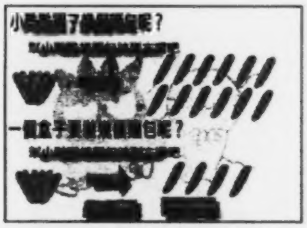


Figure 1:The Clarification of the problem

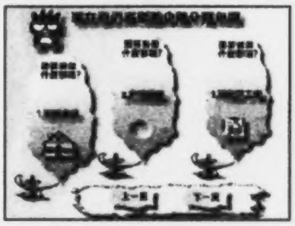


Figure 2:The choice of operation tool of problem solving

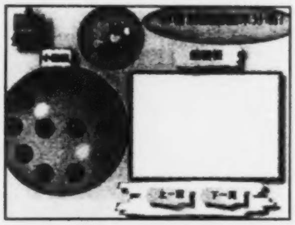


Figure 3:The presentation of thinking activity - representation

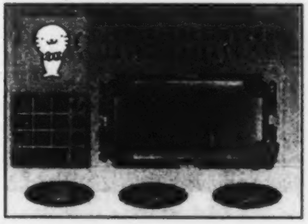


Figure 4:The presentation of thinking activity - digital and operator symbol

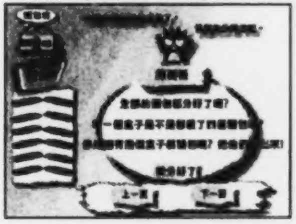


Figure 5:Reflection and discussion

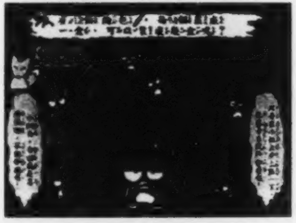


Figure 6:The strategies of virtual students

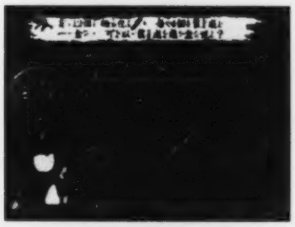
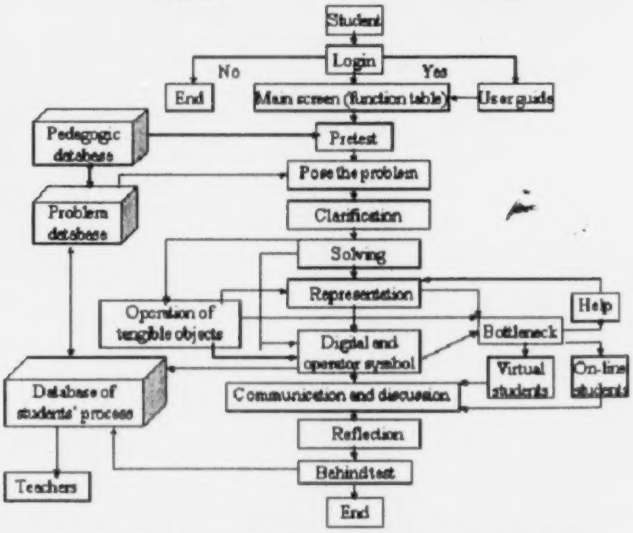


Figure 7: The communication of solving methods of virtual students


Student
Login
No
Yes
End
Main screen (function table)
User guide
Pedagogic database
Pretest
Pose the problem
Problem database
Clarification
Solving
Representation
Help
Operation of tangible objects
Bottleneck
Digital and operator symbol
Virtual students
On-line students
Database of students' process
Communication and discussion
Reflection
Behind test
Teachers
End

Figurre8: The design of networked constructive pedagogy with thinking activity

Figure 9: Group of discussion

The Development and Evaluation of a Learning Support System for Converting Web Pages

KOYAMA Yasuhiro*, YOKOYAMA Setsuo, AKAHORI Kanji***
**Graduate School of Decision Sciences and Technology, Dept. of Human System Science,*
Tokyo Institute of Technology, 2-12-1 O-okayama, Meguro-ku, Tokyo,
TEL: 03-5734-3233
yasu@ak.cradle.titech.ac.jp akahori@ak.cradle.titech.ac.jp
***Information Processing Center, Tokyo Gakugei University*
yokoyama@cs.u-gakugei.ac.jp

In recent years, the use of the Internet for school projects has become popular, even in the primary level. One of the difficulties in the use of the Internet is the arrangement and integration of Web materials to meet the learner's goals. This paper presents a tool that will help meet this challenge. It will also describe how the tool was developed and what are the results of its evaluation. The features of this tool are the following: 1) learner can easily gather Web pages as thumbnail of a screen image; 2) learner can make a list of thumbnails; 3) thumbnails can be sorted, with comments added; 4) arranged thumbnails can be displayed by HTML. Further, the learner can make a presentation using thumbnails. The authors later conducted an experiment to verify the effectiveness of this tool in arranging Web pages. The developed thumbnail tool and the browser's bookmark tool were compared. The results showed that our developed tool was more effective than the bookmark tool, especially in following areas: (1) more recognizable contents of Web pages (2) easier operation, and (3) more user-friendly for students.

Keyword: **WWW, Exploring Projects, Screen Image, Thumbnail, Bookmark**

1 Introduction

In recent years, the use of the Internet for school projects has become popular, even in the primary level. In Japan, Ministry of Education will implement the integration of technology in K-12 starting 2002. Thus, students will need to have the skills needed when using the Internet for various school subjects. For project-based learning using the Internet, the popular tool for surfing and gathering online data will be the search engine. It enables the easy gathering of various online data. But not all online data is reliable and accurate. Also, if not updated, the data or information in web pages can become obsolete. So learners need a tool that will help collect, select, organize and integrate the web pages that meet their learning needs.

Currently, the tool that is available to learners is the bookmark tool. It enables users to save Web pages with its title. It also makes it easy to access the web site's URL. But the bookmark tool leaves much to be desired in terms of the organization and integration of online data. Because data gathering using search engines is a vast task, there is an immediate need for easy browsing. The bookmark tool is a tree-structured file system, which is not quite adequate for quick and easy browsing. Moreover, it is hard for learners to appreciate the significance of Web pages when they appear only as text names when bookmarked.

In addition to doing research projects, learners also engage in making presentations of their projects using the Internet. To help learners in this activity, the authors proposed a tool that will provide students an easy way of making a file for their presentation. So, the authors developed and evaluated a learning support system which will enable learners to arrange and integrate Web more effectively.

2 Conceptual Framework for Tool Development

To reduce the load on making our choice information , the following 2-part approach was taken:

(1) The centralized of system approach. In advance searches, the tool will automatically narrow down the search to the closest level possible (filtering approach). This means the goal is an intelligent tool that can select information and improve the precision of narrowing down the search.

(2) The centralized of human approach. By adding available information as hint, in order to reduce extraneous information. This a support to the select available information.

The overall goal of this 2-part approach is to enable an easy narrowing down of a search.

When gathering web pages for a school project using the Internet, the tool that was developed by the authors enables the capturing of web pages and viewing them as thumbnail images. The authors believe that thumbnail images are more effective in providing visual cues of the content of Web pages. And, by displaying thumbnails, learners can arrange Web pages holistically, that is, they can visualize the whole composition. The authors made the hypothesis that more visual information as that provided by thumbnail images will be more effective when arranging Web pages for a project or presentation.

For presentations, the popular tool is Microsoft PowerPoint. Compared to OHP presentations, the use of motion pictures and animation makes a presentation more dynamic. But for children who are beginning computer users, the use of such tools may not be easy or may require more technology resources than what is available. But, by converting web pages directly to a HTML coding for presentation, the learning curve will be lower. So the authors proposed to add the function of being able to integrate selected web pages into a HTML coding for presentation in the development of their new tool.

3 The development of the new tool

3.1 Overview of the new tool

The developed new tool enables users to arrange Web pages using thumbnail images (**Figure1**). The functions of the developed tool are: listing thumbnails, sorting, and scrolling. The added function of a memo or comment line is to enable the users to add new information or data. The developed tool will then automatically generate the HTML coding for presentations. Through the use of HTML, learner can easily make a presentation (**Figure4**). **Figure2** shows the system configuration. The procedure for the use of the developed tool is as follows:

1) Learner displays Web pages or self-produced HTML pages using Web browser.
2) Screen image of Web pages and page title are saved to a database.
3) Lists of thumbnail from the database are displayed. Learner arranges web pages on the display, and add own comments to thumbnail.
4) Finally, using the arranged materials, learner makes a simple presentation

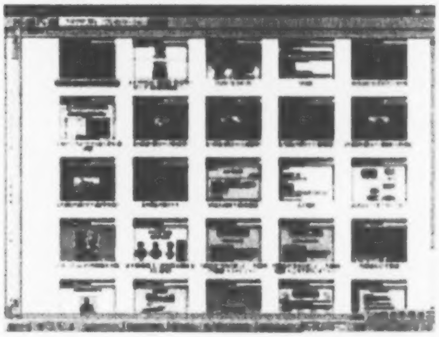


Figure1: A page showing the list of thumbnail images 1

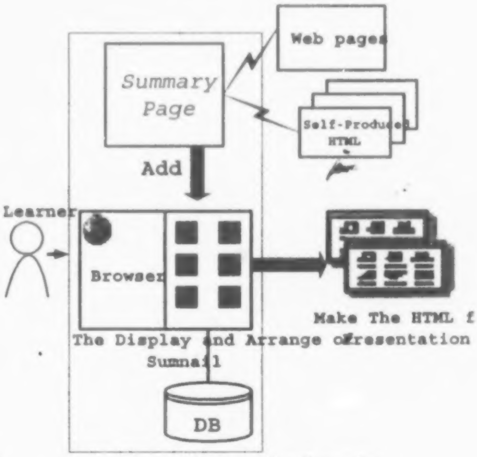


Figure2: System Configuration

3.2 The type of display Web page

In displaying the collected Web pages, the following 3 modes were used,
[1] Converting to thumbnail screen images
[2] Manipulating the original Web pages
[3] Making a presentation
The following sections explain further these 3 types.

3.2.1 Converting to thumbnail screen images

When selecting Web pages to put together, the user clicks a button to add a Web page. The web page is then converted to a thumbnail screen image (**Figure3**). Thumbnail screen images are Bitmap file made of large volume of data, so this Bitmap file is converted to a JPEG file. After that, the thumbnail is saved to the database.

3.2.2 Manipulating the original Web pages

By double clicking the thumbnail screen image, the learner can access the original Web page. It is just conceivable that learner will want to arrange the thumbnail web pages, and at the same time, have access to the original web pages. **Figure3** shows how the original web page and the lists of thumbnails are displayed at once. To change the display size, the learners can move from side to side, the display size control button located at the center of the display.

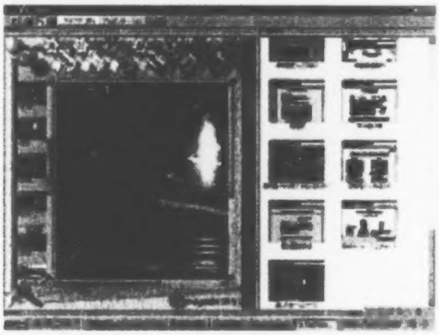


Figure3: A page showing the list of thumbnail 2

3.2.3 Making a presentation

Figure4 is the display of HTML for presentation. Arranged thumbnails are displayed in a sorted order. Learners can make a presentation using the display. Each Web page is composed of a link to the thumbnail, a link to the URL, and an area for comments or memo. The purpose here is to provide a function that will enable the easy arranging and integrating of Web pages for a presentation.

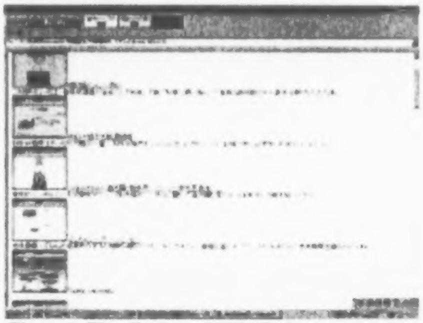


Figure4: The display of HTML for presentation

4 Evaluation of the tool

4.1 Purpose

The object of this evaluation is to verify the usability of the tool developed by the authors. Particularly, it will study the thumbnail screen images' usability for arranging Web pages. The subjects are the tool group using the developed tool and the bookmark group using only the regular bookmark tool. The groups were given the task to arrange Web pages about a specific theme. To collect data, the following were done:

(1) conduct a questionnaire survey. Subjects evaluated the operationality of the tool and were asked to give written comments of their experience of using the tool.

(2) In terms of arranging web pages, users compared the tool with the bookmark tool, and the analyses of the following data items were done.

1. work time
2. total number of times a URL is accessed
3. number of times a URL is re-accessed (the same Web page is accessed more than 2 times)
4. number of times thumbnails are sorted
5. number of times thumbnails are deleted

4.2 Method

The subjects arranged Web pages based on a theme using the developed tool and the bookmark tool. Thirty (30) Web pages were prepared in advance by the experimenter. To get a history of how they operated the tools (history of operation), a video record of how the subjects used the tool was made from a TV converter to a VHS video tape. After the experiment, the subjects answered the questionnaire. The experiment had the following stages

1. The use of the developed tool and the bookmark tool was explained to the subjects;.
2. The content of the task (theme of project) was explained to the subjects
   Theme A: the sights of Tokyo that you want to introduce to friends
   Theme B: the sights of Osaka that you want to introduce to friends
3. To eliminate order of effect, the subjects were divided into 4 groups (Table 1).

	Former	**Latter**
1Group	Theme A Using the tool	Theme B Using bookmark
2Group	Theme B Using the tool	Theme A Using bookmark
3Group	Theme A Using bookmark	Theme B Using the tool
4Group	Theme B Using bookmark	Theme A Using the tool

Table1: Subject groupings in the experiment

4.3 Results

To compared the developed tool and bookmark tool, questionnaire data was analyzed for significance using the t-test The results are given in **Table2**.

	Average	**Result**
Thumbnail screen image is more recognizable	**4.17**	**
The lists of thumbnail are more recognizable	**4.17**	**
Useful for arranging web pages	**3.83**	*
Recognizes the contents of a web page	**4.33**	**
Useful for school projects that use the Internet	**4.67**	**
Useful for making a presentation	**4.42**	**

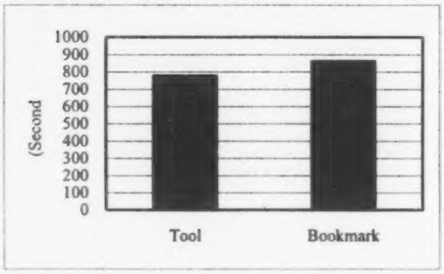
*p<.05,**p<.01 t-test (two-tail test) the average(max5)

Table2: The results of the questionnaire

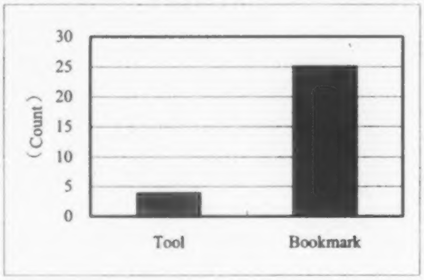
T-test results show that web page titles with thumbnails are more recognizable than text-only web page title. And as to browsability, the lists of thumbnail are more recognizable than the tree structure of the bookmark tool. Inquiry as to "useful for arrangement" was significant at the 0.05 level. But as to the ability of operation in the questionnaire, couldn't get level of significance. Because the interface of sorting the thumbnails will not be enough to good for learner.

In the analyses of the history of operation (reference 4.4 (2)), the record shows that the thumbnail screen image is useful to learner when arranging web pages. The results are indicated in **Figure6-10**. From the results, the following items were verified:

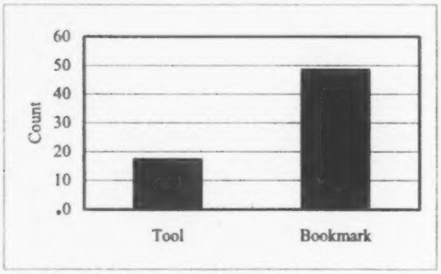
* For shorter work time, the developed tool is comparatively more efficient than the bookmark tool (Figure6).
* By using the thumbnail screen image, the learner is able to better recognize the contents of the web page (Figure7,8).
* Lerner is comparatively able to estimate whether to use web pages or not (Figure10).



+p<.1
Figure6: Comparing the average of work time



**p<.01
Figure8: Comparing the average number of times of re-accessing URL



**p<.01
Figure7: Comparing the average of the total number of times of accessing URL

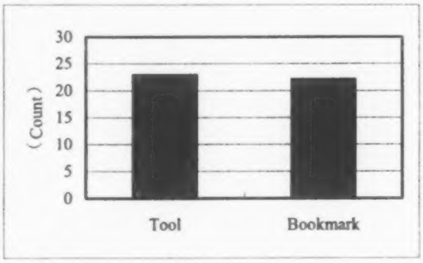
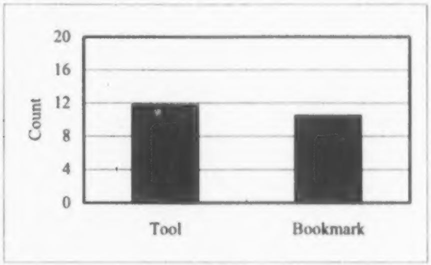


Figure9: Comparing the average number of times of sorting thumbnails



+p<.1
Figure10: Comparing the average number of times of deleting thumbnails

4.4 Analysis

The results of the evaluation procedures show that

1) based on the questionnaire, there were good results as to the functionality of the thumbnail screen images. And from the subjects' comments, "the lists of thumbnail is useful", "helps better recognize contents of the web page", and "the arrangement of web pages using the tool is convenient and useful".
2) based on the results of history of operation, work time, in terms of the number of times of accessing and re-accessing the URL and the number of times of deleting thumbnails, got good results in the given level of significance.

In terms of browsability, providing the user with a list of thumbnail is more useful than the bookmark tool. Accordingly, for arranging web pages, the list of thumbnail was better for integrating the collected data and for reviewing them. For arranging web pages, the results of the history of operation show that the developed tool is more useful than the bookmark tool.

5 Conclusions

In this research, a tool for learning to support the arrangement and integration of web pages was developed and evaluated. The results of the study can be summarized as follows:

1. Development of the learning supporting tool
   This research addressed the problem of selecting information for research projects using the Internet [1.Introduction], and examined how to resolve the problem by developing a tool that is both effective and user-friendly. The research also considered the interface of the tool and provided a conceptual framework [2.Conceptual Framework for Tool Development] in its development.
2. The evaluation of subjects about ease of operation and usefulness of the tool
   In the experiment phase of the paper [4.The evaluation of tool], a questionnaire was used to measure the as to ease of operation and usefulness of the tool., and got good results.
3. Verifying the efficiency of the tool for manipulating web pages
   When it comes to accessing and re-accessing URLs, the tool was more useful than the bookmark tool. For arranging web pages, the availability of a list of thumbnail images made it easier to integrate the selected web pages and to review them.

5.1 Future Studies

For future studies, the following are recommended:

1) Modification of the tool and adding more functions
2) A detailed analysis of the operation history

Acknowledgement

The authors would like to thank Dr. R. Santiago for her great assistance.

References

[1] Akai, K. and Koike, H., "Experimental Studies on Visual Search of Image Files" (in Japanese), The Special Interest Group Notes,: Information Processing Society of Japan(IPSJ), Vol.98, No.35, 98-H1-78, pp.27-32(1998)

[2] Ueda, M., "Development of a system of learning support using the Internet" (in Japanese),: Japan Society for Educational Technology(JET), 99-4, pp.9-16(1999)

[3] Mizobuchi, S. and Furuyama, T., "An analysis on the effect of indexes on WWW information selection process" (in Japanese), The Special Interest Group Notes of IPSJ,: Information Processing Society of Japan(IPSJ), Vol.98, No.116, 98-H1-81, pp.31-36(1998)

The Impact of Web-Based Interactive Multimedia on Conceptual Development

Ying-Shao Hsu
Department of Earth Sciences
National Taiwan Normal University, Taipei, Taiwan
yshsu@cc.ntnu.edu.tw

The purpose of this study was to examine students' conceptual development through their use of a web-based interactive multimedia under different instructional strategies. A web-based interactive multimedia was developed to facilitate students' conceptual development in condensation in this study. We selected first-grade students in Luodong Senior High School as the sample. In view of the results, there was no sufficient evidence that showed significant difference of students' learning between traditional instruction and a web-only or teacher-web instruction. One of reasons was that some students in the groups of web-only instruction and teacher-web instruction cannot complete their learning activities in 70 minutes. Further work on promotion of students' computing skills and science process skills should be warranted before examining the effects of web-based lessons on students' conceptual development.

1 Background and Rationale for Study

Recent developments in computer technology are providing new support to the learning environment. These developments make complex human-machine interaction and multimedia products possible and powerful and make accessing structured information sources much easier. The forms and functional elements of the multimedia consist of text, graphic images, audio, video, and animation . The merging of various types of media allows learners select their own mode/representation during learning and make associations or links between the different representations (McCarthy, 1989). Ambron (1986) sees computer-based multimedia learning stations allowing users to "browse, annotate, link, and elaborate on information in a rich, nonlinear, multimedia data base, explore and integrate vast libraries of text, audio, and video information" (p. 7). Schroeder (1991) pointed out that interactive multimedia systems should include the following components: 1) the information or data system; 2) the software for accessing the information; 3) the hardware or technology; and 4) the communications system needed to connect all these parts. The digitization of media and the rapid growth of networks make storage and retrieval of digital material, local or remote, possible under users' choices. Choices made by the user determine how the system responds to and what information is going to present next. Such learning materials that includes many types of media incorporating with dynamic linking are called interactive multimedia.

A computer simulation named mtnSim, which is an interactive multimedia, was designed with authentic situations, multiple representations, and the capability of reviewing previous actions supporting science learning. Interacting with an instructional simulation can enable learners to gain a better understanding of a real system, process or phenomenon through exploring, testing hypotheses, and discovering explanations for the mechanisms and processes (Burton et al., 1984; Goldenberg, 1982; Lunetta & Hofstein, 1991; Mellar & Bliss, 1993; Raghavan & Glaser, 1995). In order to engage learners in higher-order thinking, such as hypothesis testing and speculating, simulations need to be designed as easy-to-manipulate environments that enable learners to experiment with ideas. Thomas and Hooper (1992) stated: "A computer based instructional simulation is a computer program containing a manipulatable model of a real or theoretical system." (p. 498). Simulation differs from a flexible tutorial environment in that instructional simulation does not provide explicit feedback, but alters the state of the model in response to students' actions in accordance with rules governing the simulated system. The researcher thinks the definition of instructional simulation by Thomas and Hooper seems to support learner-centered learning. Therefore it is adopted in this research.

Well-designed simulations should promote realism, encourage exploration, permit multiple representations and enable recording. Thus, the simulation design should be the integration of these features and learning theories. Moreover, these structured simulation environments are often safer, much less expensive and easier to access than the real-world counterparts (Recker, Govindaraj, & Vasandani, 1998). The computer simulation used in this research, called MtnSim (see Fig 1), was designed with the structured simulation environments as guidelines. The purpose of this study was to examine students' conceptual development after they used a web-based interactive multimedia under different instructional strategies.

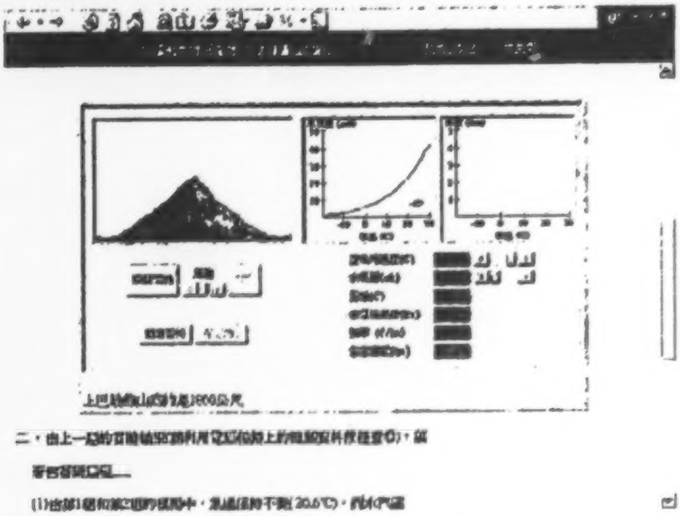


Fig 1: The appearance of mtnSim

2 Methodology

In this study, the author used experimental research for collecting data. The data collection consisted of the integration of three instruments: web-based interactive multimedia, paper-and-pencil tests, and questionnaire of attitude to computers, and computer protocols. Students participating this study took the pretest a week before the treatments (three types of instructions each lasted 70 minutes). All students' actions were recorded through the network to a central database. The posttest was administrated one week after the treatments.

Sample

First-grade students in Luodong Senior High School were selected as the sample in this study. There were 39 students in the group of traditional instruction, 21 in the group of web-only instruction and 22 in the group of teacher-web instruction.

Instruments

1. Web-Based Interactive Multimedia (Air Over Mountains)

A lesson, "Air Over Mountains", in form of web-based interactive multimedia was designed and deployed onto the site called "The Depot of Instructional Resources in Earth Sciences"(URL=http://earth.geos.ntnu.edu.tw/depot/index.asp). The lesson consists of three parts: (a) daily-life examples: In order to connect students' daily-life experiences, students can see pictures which show drops of water on the wall inside a half-full bottle for a period of time, some drops of water outside a can of icy drink, and mist on the glasses when some one eats hot food (see Fig 2-4). Those are good examples for condensation in daily life and they can help students to retrieve knowledge for further learning. (b) clouds around one side of the mountain: Weather data (see Fig 5-7) show it is different between the windward side and the leeward side of the mountain. Why are there more rainfalls on the windward side during winter in Taiwan? Students can use MtnSim (a web-based simulation, see Fig 1) to test out their ideas about this question. The main concepts in the MtnSim simulation are condensation aloft and adiabatic temperature changes. Condensation occurs either when water vapor is added to the air or when the air is cooled to its dew point (Lutgens & Tarbuck, 1992). The adiabatic process causes temperature change; either it cools down when air is allowed to expand or it warms up when air is compressed. The mountain forces air to move upward to higher altitudes and the air expands as it passes through regions of successively lower pressure. This process is called adiabatic cooling which makes cloud formation possible. In contrast, as air descends the leeward side of the mountain it becomes warmer and drier due to compression. With the realistic image of a mountain and the actual sounds of wind and thunder, MtnSim can evoke the learners' stimuli of perception. This design that tries to embed students in authentic situations may motivate learners to engage in extended exploration of this simulation. (c) foehn: The definition and weather data of foehn are provided. Students can find out the characteristics of foehn by watching weather data. Then, they can learn more about what causes foehn by testing ideas in MtnSim as well.

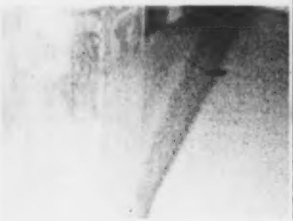


Fig 2: half-full of bottle

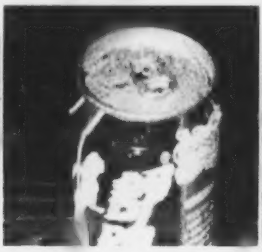


Fig 3: A can of icy drink

Fig4: mist glasses

Fig 5: A map of Taiwan

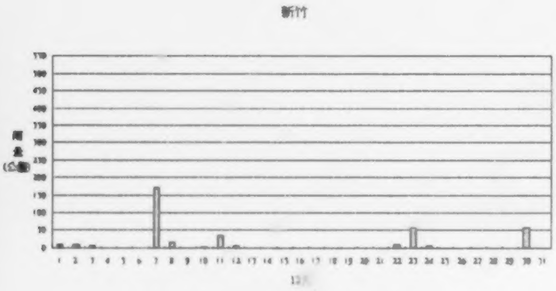


Fig 6: Weather data at Hsin-Chu weather station

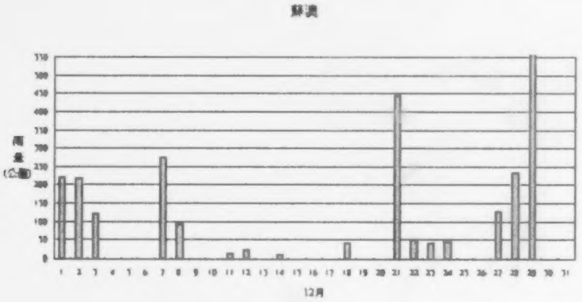


Fig 7: Weather data at Su-Ao weather station

2. Pretest and posttest: In order to investigate students' conceptual development, a test on concepts related to saturation and condensation (20 items) was used for both pretest and posttest.
3. Survey of attitude to computers: The questionnaire was designed to investigate students' attitude to computers including 24 items.

Data Analysis

The treatment was the independent variable of this study. Comparisons among three groups, traditional instruction, web-only instruction, and teacher-web instruction were investigated. For traditional instruction, the teacher printed out the pictures used in the web-based lesson and made them as transparences in order to make the same concepts taught in classroom as in the web-based lesson. For web-only instruction, students worked with "Air Over Mountains" lesson alone in a computer room. For teacher-web instruction, the teacher provided instructional directions when students interacted with "Air Over Mountains" lesson in a computer room.

Two dependent variables were measured, conceptual understanding (pretest and posttest) and attitude to computers. After the collection of data, analysis of variance (ANOVA) was used to analyze the data. The significant level of 0.05 was used for all statistical tests in this study.

Results

The results of the research are represented with a list of research questions and their answers derived from the data analysis.

Question #1: Is there difference on students' concepts between before and after interacting with web-based interactive multimedia?

To examine whether there were significant differences in students' conceptual development between before and after using "Air over mountains" lesson or before and after classroom teaching, repeated t tests were calculated (see table 1). The data analysis indicated that there was no significant difference in students' conceptual development between before and after using "Air over mountains" lesson either in web-only instruction group or teacher-web instruction group. However, there was a significant difference before and after classroom teaching. The teacher printed out the pictures and graphs from "Air over mountains" lesson as transparencies. With the same materials, the teacher interacting with students in classroom made students' understanding better. The possible reason was that the pictures and graphs were well-illustrated by the experienced teacher who had taught Earth Science in Senior High School for about 10 years. The factor of teacher characteristics played an important role in this case.

Table 1: Repeated t tests for pretest and posttest of concepts

	Mean (SD)		Repeated t values
	pretest	posttest	
Traditional instruction	11.5 (2.25)	13.1 (2.44)	4.81 ($p<0.00$**)
Web-only instruction	11.5 (2.54)	11.6 (1.86)	0.24 ($p<0.81$)
Teacher-web instruction	10.8 (2.34)	11.2 (3.27)	0.64 ($p<0.53$)

Question #2: Is there difference on students' concepts between three instructional groups?

To investigate whether a significant difference in students' conceptual development between three instructional groups, a repeated one-way analysis of variance was calculated. The independent variable was the type of instructional activity and the dependent variable was the score of test on concepts related to saturation, condensation, and foehn. The data analysis showed there was a significant difference in students' conceptual development between three instructional groups (see Table 2). From Post-Hoc analysis, students' conceptual development in the group of traditional instruction was significantly higher than the groups of web-only instruction and teacher-web instruction. One of reasons was because students in the groups of web-only instruction and teacher-web instruction cannot complete their learning activities in 70 minutes. Students need to be well-trained in computing skills before they used web-based lessons so that they can save time on typing.

Table 2: Repeated one-way ANOVA for students' conceptual development for three groups

	Mean (SD)		Repeated one-way ANOVA
	pretest	posttest	
Traditional instruction (N=39)	11.5 (2.25)	13.1 (2.44)	F=4.12(P<0.02**)
Web-only instruction (N=21)	11.5 (2.54)	11.6 (1.86)	
Teacher-web instruction (N=22)	10.9 (2.34)	11.2 (3.27)	

Question #3: Is there difference of students' attitude to computers between three groups?

To test if there was a significant difference in students' attitude to computers between three types of instructional groups, a repeated one-way analysis of variance was calculated (see table 3). The independent variable was the type of instructional activity and the dependent variable was the score of questionnaire on attitude to computers. The data analysis showed there was not a significant difference in attitude to computer between three types of instructional groups.

Table 3: Repeated one-way ANOVA for students' attitude to computers

Scores on Attitude	Mean (after recoding negative items)		Repeated one-way ANOVA
	pretest	posttest	
Triditional instruction (N=39)	89.3	86.6	F=1.10 (P<0.34)
Web-only instruction (N=21)	88.5	87.4	
Teacher-web instruction (N=22)	95.5	95.4	

3 Conclusions

The purpose of this study was to examine students' conceptual development after they used a web-based interactive multimedia under different instructional strategies. Unfortunately, there was no satisfactory evidence that showed students learned better in a web-only or teacher-web instruction. The possible reason was that students did not possess enough computing skills such as typing and browsing web page, and science process skills such as understanding the meaning of weather data, exploring the simulation controlling variables, and making sense of relationships between variables. It is suggested to accommodate students more trainings on computing skills and science process skills before examining the effects of web-based lessons on students' conceptual development.

References

1. Ambron, S. (1986). New visions of reality: Multimedia and education. LEARNING TOMORROW: JOURNAL OF THE APPLE EDUCATION ADVISORY COUNCIL, 3 5-13. ERIC number ED 302

180.

2. Burton, R. R., Brown, J. S., and Fiscker, G., (1984). Skiing as a model of instruction. In B. Rogoff and J .Lave, Everyday cognition: Its development in social context. Cambridge, MA: Harvard University Press.
3. Goldenberg, E. P., (1982). Logo: A cultural glossary. Byte, 2, 210-299.
4. Kafai, Y. B., (1995). Mind in play: Computer game design as a context for children' s learning. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.
5. Lunetta, V. and Hofstein, A., (1991). Simulation and laboratory practical activity. In B. Woodnough, Practical science. Miltonkeynes, PA: Open University Press, (pp. 125-150).
6. Lutgens, F. K. and Tarbuck, E. J., (1992). The atmosphere: An introduction to meteorology . Englewood Cliffs, NJ: A Simon & Schuster Company.
7. McCarthy, R. (1989, June). Multimedia: What the excitement's all about. ELECTRONIC LEARNING, 8(3), 26-31. ERIC number EJ 395 537.
8. Mellar, H. G. and Bliss, J., (1993). Expression the student's concepts versus exploring the teacher's: Issues in the design of mociroworlds for teaching. Journal of Educational Computing Research, 9(1), 89-112.
9. Raghavan, K. and Glaser, R., 1995, Model-Based analysis and reasoning in science: The MARS curriculum, Science Education, 79(1), 37-61.
10. Recker, M. M., Govindaraj, T. & Vasandani, V. (1998). Student diagnostic strategies in a dynamic simulation environment. Journal of Interactive Learning Research m 9(2), 131-154.
11. Schroeder, E. E., (1991). Interactive Multimedia Computer Systems. ERIC Digest. ERIC Document Reproduction Service No. ED340 388.
12. Thomas, R. A. and Hooper, E., (1992). Simulations: An opportunity we are missing. Journal of Research on Computing in Education, 23(4), 497-513.

The Internet-based Educational Resources of the U.S. Federal Government

Andy Wang* and Krishelle Leong-Grotz**
**University of California at Berkeley,*
2325 Blake Street, #201, Berkeley, CA 94704,
andy@café.berkeley,edy
***Case Western Reserve University*
School of Medicine, Class of 2003,
ktl3@po.cwru.edu

The Internet is an international computer network composed of thousands of smaller networks. Recently, through United States federal, state, and regional education networks and commercial providers, the vast resources of the Internet are increasingly available to administrators, school library media specialists, and classroom teachers. The web puts learning within the reach of anyone with Internet access. One of the most popular uses of this new medium, among teachers, is searching for ways to help students learn. But finding the right information on a particular topic for their students takes time. Current initiatives, such as FREE, GEM, ERIC, and Parents Guide to the Internet, meet this goal of improving online learning resources. This paper aims to introduce some of the United States' successful programs.

1 Introduction

One of the main priorities of the Clinton administration is to make sure that all Americans have the best education in the world. One of the goals of this "Call to Action for American Education" is to bring the power of the Information Age into all schools in the United States. This initiative requires connecting every classroom and library to the Internet, making sure that every child has access to multimedia computers, giving teachers the training they need to be as comfortable with the computer as they are with the chalkboard, and increasing the availability of high-quality educational content. When America meets the challenge of making every child technologically literate, children in rural towns, suburbs, and inner city schools will have equal access to the same knowledge base.

United States Federal agencies have made significant contributions to expanding this knowledge base. For example, "White House for Kids," is a home page with information on the history of the White House. NASA has a K-12 initiative, allowing students to interact with astronauts and to share in the excitement of scientific pursuits such as the exploration of Mars and Jupiter, and the experiments conducted on the Space Shuttle. Students participating in the GLOBE project (Global Learning and Observation for a Better Environment) collect actual atmospheric, aquatic, and biological data and use the Internet to share, analyze, and discuss the data with scientists and students all over the world. With support from the National Science Foundation, the Department of Energy, and the Department of Defense's CAETI program (Computer-Aided Education and Training Initiative), the Lawrence Berkeley Laboratory has developed a program that allows high school students to request and down-load their own observations of the universe from professional telescopes.

Of these government programs, four of these are as follows:

2 FREE (Federal Resources for Educational Excellence)

On April 18, 1997, President Clinton asked Federal agencies to determine what "resources you can make available that would enrich the Internet as a tool for teaching and learning." In response, more than 40

Federal agencies formed a working group to make hundreds of federally supported education resources available on the FREE website.

Some of the subjects of the FREE include arts, educational technology, foreign languages, health and safety, and mathematics. Agencies involved include Centers for Disease Control and Prevention, National Gallery of Art, National Science Foundation, Peace Corps, Consumer Product Safety Commission, and the Smithsonian Institution.

3 GEM (Gateway to Educational Materials)

GEM began in 1996 after the National Library of Education (NLE) Advisory Task Force sought to find ways to apply library and information science skills to help educators find lesson plans and teacher guides on the Internet. GEM provides links to free Internet materials, partially free materials, and to resources that require a fee or registration to be used. There are two ways to access the education resources on GEM —Browsing and Searching. Browsing GEM is sampling from lists of predetermined categories (e.g. mathematics, language, education by grade level). Searching GEM is looking for any information containing the keywords of the query (e.g. algebra lesson plan). This website provides access to educational materials found on various federal, state, university, non-profit, and commercial Internet sites.

4 ERIC (Educational Resources Information Center)

The Ask ERIC service (Education Resources Information Center), supported by the Department of Education, has a virtual library of more than 900 lesson plans for K-12 teachers, and provides answers to questions from educators within 48 hours – using a nationwide network of experts and databases of the latest research. Abstracts of some 1,300 (Educational Research Information Center) ERIC Digests are available online and text-searchable. A menu of services offered on the Internet not only introduces the user to ERIC documents, but also leads to other databases in education. It began in 1992 as a project of the ERIC Clearinghouse on Information and Technology and is now, with the ERIC Clearinghouse, a component of the Information Institute of Syracuse at Syracuse University. Today, Ask ERIC encompasses the resources of the entire ERIC system and beyond. Got an education question? Ask ERIC! The main components of Ask ERIC are:

1. Ask ERIC Question & Answer (Q&A) Service
   Need to know the latest information on special education, curriculum development or other education topics? Just Ask ERIC! When you submit your education question to Ask ERIC Q&A, you' ll receive a personal e-mail response from one of our network information specialists within two business days! We will send you a list of ERIC database citations that deal with your topic and will also refer you to other Internet resources for additional information. It' s that easy!

2. Ask ERIC Virtual Library
   The Ask ERIC Virtual Library contains selected educational resources, including 1000+ Ask ERIC Lesson Plans, 250+ Ask ERIC Info Guides, searchable archives of education-related listservs, links to Television Series Companion Guides, and much more!

3. Search the ERIC Database
   The ERIC database, the world' s largest source of education information, contains more than one million abstracts of documents and journal articles on education research and practice. By searching Ask ERIC' s web-based version of the ERIC Database, you can access the ERIC abstracts, which are also found in the printed medium, Resources in Education and Current Index to Journals in Education. The database is updated monthly, ensuring that the information you receive is timely and accurate.

5 Parents Guide to the Internet (16 page informational booklet)

This new, 16-page booklet, produced by the U.S. Department of Education, gives parents an introduction to the Internet and is "intended to help parents--regardless of their level of technological know-how--make use of the on-line world as an important educational tool. The guide cuts through the overwhelming amount of consumer information to give parents an introduction to the Internet and how to navigate it. Most importantly the guide suggests how parents can allow their children to tap into the wonders of the Internet while safeguarding them from its potential hazards.

This guide was produced with the sort of collaborative effort that American schools need in order to succeed. U.S. Department of Education staff worked with leaders from parent and education organizations, the private sector, nonprofit groups and others in order to give parents a clear and comprehensive overview of the Internet and its vast educational potential. In the same way, schools need support from every corner of the community in order to provide students with a high-quality education.

6 Conclusion

More than ever before, a high-quality education offers Americans the best path to a rewarding career and a fulfilling quality of life. As citizens of the Information Age, Americans must include access to technology among the elements of an education that is based on high standards of achievement and discipline. But incorporating technology into the Nation's schools is too big a job for the schools to tackle on their own. Teachers need support and involvement from parents, grandparents, businesses, cultural institutions and others in order to make effective in-class use of the wonders of technology.

The Internet is an international computer network composed of thousands of smaller networks. Recently, through United States federal, state, and regional education networks and commercial providers, the vast resources of the Internet are increasingly available to administrators, school library media specialists, and classroom teachers. The web puts learning within the reach of anyone with Internet access. One of the most popular uses of this new medium, among teachers, is searching for ways to help students learn. But finding the right resource on a particular topic for their students takes time. And time is in short supply for our teachers. Current initiatives, such as those outlined, FREE, GEM, ERIC, and Parents Guide to the Internet, meet this goal of improving online learning.

References

1. Becker, Henry J. Information Technology in Teacher Education: Survey of Current Status. Washington, D.C.: National Technical Information Service, U.S. Department of Commerce, March 1994.
2. Bernie Poole's EdIndex, Web Resources for Teachers and Students, http://www.pitt.edu/~poole/edmenum.html
3. Consortium for Policy Research in Education. CPRE Policy Briefs, June 16, 1995.
4. Cotton, E. G. (1998). "The Online classroom: Teaching with the Internet, third edition." Bloomington, IN: EDINFO Press. (ISBN-1-883790-29-8). (ED 413 606)
5. Educational Resources Information Center (ERIC) web site, http://www.askeric.org/
6. Federal Resources for Educational Excellence (FREE) web site, http://www.ed.gov/free/.
7. Gateway to Educational Materials (GEM) web site, http://www.thegateway.org
8. Junion-Metz, G. (1996). "K-12 resources on the Internet: An instructional guide." Internet workshop series, number 5. San Carlos, CA: Library Solutions Press. (ISBN-1-882208-14-5). (ED 389 316)
9. K-12 computer networking. (1995). "The ERIC Review," 4(1). (ED 392 413)
10. Lankes, R. D. (1996). "Bread and butter of the Internet." ERIC Digest. Syracuse, NY: ERIC Clearinghouse on Information & Technology. (ED 402 925)
11. Maeroff, Gene I. Changing Teaching: The Next Frontier. The National Foundation for the Improvement of Education, 1994.
12. McKinnon, P. Alistair, and Clesson S. Bush. "Technology for Education: What is the Federal Role?" Educational Technology 4 (1993): 37-41. Michalski, Jerry. Release 1.0: Esther Dyson's Monthly Report. New York: EDVenture Holdings, Inc., May 1995.
13. Milken Family Foundation. Expanding Classroom, Shrinking World: Resource Guide. Los Angeles, May 4, 1995.
14. National Center for Education Statistics, U.S. Department of Education. Advanced Telecommunications in U.S. Public Schools, K-12. Washington, D.C.: U.S. Government Printing Office, 19[illegible]5.
15. National Center for Education Statistics, U.S. Department of Education. Annual Revenues and Expenditures: Public K-12 Schools. Washington, D.C.: U.S. Government Printing Office, 1991 and 1994.

16. Parents Guide to the Internet web site, http://www.ed.gov/pubs/parents/internet/
17. Serim, F. & Koch, M. (1996). "NetLearning: Why teachers use the Internet." Sebastopol, CA: Songline Studios, Inc. and O'Reilly & Associates, Inc. (ED 396 700)
18. Tennant, R. (1996). Internet basics: Update 1996. ERIC Digest. Syracuse, NY: ERIC Clearinghouse on Information & Technology. (ED 392 466)
19. U.S. Congress, Office of Technology Assessment. Teachers and Technology: Making the Connection. Washington, D.C.: U.S. Government Printing Office, April 1995.
20. U.S. General Accounting Office. School Facilities: America's Schools Not Designed or Equipped for 21st Century. Washington, D.C.: U.S. Government Printing Office, 1995.

The network learning supported by constructivism

Song-Min Ku
E-mail:sppman@icemail.nknu.edu.tw

1 Introduce

Network learning gives a chance to educators to rethink and investigate the learning modules and styles. Therefore the educators can rearrange learning strategies and develop new learning environment to validate the learning strategies and ideas. Although network learning cannot affect the learning completely and fully, at least network learning offer the environment to fulfill the ideas of constructivism.

2 Setting up the network learning environment

2.1.To provide multiple and abundant materials:

The network learning resources provide the objective and existed knowledge, the multi-angle and multi-level experiences to give learners various stimulations. In other words give the learners a chance to create multiple constructions, the same learner create different level construction at distinct time.

2.2.Give learners the authentic problems:

The important mission when teachers proceed with the instruction of constructivism is to arrange and provide the abundant and fitted learning environment, to offer and assist learners to construct knowledge actively and successfully.

2.3.Encourage learners raise various solving methods for the problems:

Promote learners to think of the problems by multi-angle ways. In order to encourage learners to discuss, think, argue and learn cooperatly, thus the learning have to be proceeded with dialog and communication.

2.4.Clear learning goals and concepts:

In internet world no place is too far away to be reached. If let learners grope or learn alone, it's usually happen that learners disorientate in the internet world. Thus if there is no clear goal, learning activity will be one pattern of browse and the emphasis will be neglect. Let learning activities concentrate at the learning goals or concepts, learners will get more complete knowledge, understand the key points, thus increase learning effects.

2.5.Learners can present viewpoints fully:

The internet world is a multi-person and pluralistic environment . In addition to self-learning, learners can see the learning portfolios of others. The learners review the cognition of others by self-viewpoint, furthermore to imitate and learn the others, and self-viewpoint can also be referred by others. Learners develop one kind of self-thinking in the environment of arguing with others again and again. Thus learners are no more silencers, but the learners are encouraged to present their viewpoints or opinions.

2.6.Adaptive courses:

There are individual differences between learners, learning processes or learning strategies of learners are different from others. Thus the design of courses should be considered about the individual difference,adapted to learning situation of learners. Arrange different course to match the learning situation and abilities of learners, thus learners got the individual learning.

3 Conclusion

It's convenient to search information and data in World Wide Web. The convenience is important factor to encourage learners to construct the self-knowledge. In the process of learners participating and learning actively, learners will feel that they have got self-learning goal.

In constructivism it's important factor that learners participate actively in learning process. Thus learners must participate self-learning activity positively. Learners should search and find knowledge what they want actively.In network learning environment the learning activities are emphasized the" internal control" directed by learners, and requesting learners to learn by their strategies in the process of learning activities.

4 References

[1] Chih-Yu Chan(1996),"Cognition and Knowledge: Constructivism VS. Acceptance", Journal of Education Research, 49,25-38.

[2] Chi-Hsien Lin(1999),"The design and application of network leaning environment", Journal of Information and Education,67,34-48.

[3] Kuei-Fa Chiu,(1996). "Situation learning concept and computer aided learning: The study of learning community " Taipei: Shih Ta Press.

[4] Kuei-Fa Chiu,(1996). "The study of network learning: The another space of education research", The 12th Science Education Seminar, Roc. December.

[5] Kuei-Fa Chiu,(1997), " The development of network learning environment supported by education", Environment education and information network seminar, May.

[6] Shih-Ju Chang(1997),"The meaning of internet hypertext and hypermedia applied in instruction with constructivism", Journal of Information and Education, 58 ,39-48.

The Production of Web-based Interactive Video From Structured Script

Cheng-Huang Yen
Dept. of Management & Information, National Open Univ.
172 Chung-Cheng Road, Lu Chow, Taipei County, Taiwan 24702
Tel: +886-2-22894846
Fax: +886-2-28484944
E-mail:yench@mail.nou.edu.tw

The use of AV (audiovisual) media has had great impact on instruction in distance education. However, lack of a systematic methodology, existing instructional video programs cannot be used as effectively on Web as in the case of TV broadcast. Simply by digitizing video programs to AV streams will not gain much from learners' view. In our research, we propose the notion of structured script writing. The design and production of Web-based interactive video from structured script enhances reusability of content modules and reduces demand on network bandwidth. Most importantly, learners are able to conduct a hyperlink-style learning process which turns out to be much more effective than viewing video programs sequentially. Learning activities are also easily integrated with digitized media.

Keywords: **Web-based learning, Distance education, Audiovisual media production**

1 Introduction

TV production has been an effective, though expensive way to create AV media for instructional purposes. Every finished video includes an amalgamation of elements recorded in a script. A script simplifies production by specifying what and how settings, action, and actors become part of the video so the director can plan ahead. Although TV production runs routinely, the quality and effectiveness of every instructional video differs significantly. It has been evidenced that the script stage is critical for successful TV production. In our research, we take script writing to another level; i.e., structured script. The major goals are as follows:

1. *Enhance reusability of content module:* The video programs can be partitioned into reusable modules such that instructional elements may be reused or shared among different programs. Structured scripts lead to a natural partition of video programs.
2. *Facilitate the design of Web-based learning material:* The notion of hyperlinks has been used in the production of Web-based learning and training material. Embedded standard and extended tags appeared in structured scripts can map video content to HTML-like format. The mapping can be automated by software.
3. *Reduce the demand on network bandwidth:* Without partition, video programs are streaming down to users' computers which are normally hooked up to the Internet by low-bandwidth access lines. A proper partition by topic will eliminate the need to transfer the whole program and thus save 30% to 70% of bandwidth usage.
4. *Automate the production of Web-based interactive video:* A typical distance education institution produces an average of 40 video programs per semester. The length of a video program ranges from 30 minutes to 20 hours. This amounts to a mass production of instructional video programs within a very short timeframe. It is both a need and a demand to automate the transformation of traditional video program to Web-based interactive video. The channels of distribution can also be diversified.
5. *Enable flexible learning sequences:* Traditional TV broadcast forces learners' to follow a non-stop sequential format which is inconvenient and against the nature of individualized open learning. Web-based open learning provides a variety of learning sequences and formats.

2 Related Research

In our research, video-based instructional media refer to traditional studio production or live instructional activities recorded on tape for later broadcast or distribution [8]. From learners' point of view, simply by watching the instructional video offers no experience of interaction. However, the visual content along with good design at the script stage could provide great assistance to learners, especially in the area of distance education. The use of interactive video in instruction and learning has been practiced extensively in both academic and corporate environments [3,5]. Improvised video programs can hardly provide effective assistance in a formal learning situation which requires precision and in-depth coverage.

Including the script stage in the video production process is a legitimate choice in most successful cases [4,8]. However, the sequential and flat nature of traditional script does not leave much room for integration with other media and for adding interaction. Structured scripts, like HTML in WWW, open a new way for producing effective Web-based interactive video. Recent advances in virtual university and network-based education suggest widespread use of computer-based media [1,2]. AV media can become part of the computer-based media [7]. However, traditional institutions need to pay for extra investment on video production and distance education institutions need to find a way to transform their video assets to digital merchandise. Structured scripts will help solve the dilemma.

3 A Definition of Structured Script

A typical script includes a video and an audio part presented along a sequential timeline. Various techniques can be used to enhance the presentation of instructional content in a video program. The elements of a script may appear in any format listed in Table 1. The adoption of these formats depends on the nature of the program, the design by content and media expert, etc. A script may contain a combination of several different formats of presentation.

Table 1. Popular presentation styles

1	*Commentary*
2	*Single performer*
3	*Interviews*
4	*Talk shows*
5	*Illustrated talk*
6	*Demonstrations (music/dance/computer)*
7	*Drama*
8	*Electronic insertion*

Most script writers are aware of different formats of presentation. However, few of them notice the formats' implications on how the video programs can be partitioned. Table 2 lists a typical script that follows traditional style. Based on the script, the director knows when, what and how to record on the tape. The actor is also aware of what should be performed by viewing the script. By the time the video program is finished, we need to scan through the tape to find a way to divide the program into video content modules. Just by looking at the script will not give us much clue about how the partition should be made.

Table 2. Non-structured scipt

Video	**Audio**
TC Java Basics 1. basic concepts 2. resources 3. related topics	Java is an object-oriented programming language. JDK (Java Developer's Kit) provides Java compiler and other tools for developing Java applications. ……
SP	Java is noted for its support for cross-platform software development. Many Internet applications are written in Java.

Without making too much change, we re-write the same script as shown in Table 3, the so-called structured script. In our definition, a traditional script is composed of a video and an audio part synchronized along the timeline. A structured script is, on the other hand, distinguished by the following features: .

1. *The margin of divisible units should be clear.* Suppose the video program will be partitioned by topics, the start and end of a topic should be signaled by some sort of tags. For example, the STC tag in Table 3 denotes the start of the topic, Java.
2. *There exists a hierarchy that organizes and inter-relates all units.* For example, the script in Table 3 reveals a hierarchy shown in Figure 1. The elements in the video part must be organized by certain content-specific criteria.

Table 3. Structured script

Video	Audio
STC Java	{music}
TC Java basics	Java is an object-oriented programming language. JDK
1. basic concepts	(Java Developer's Kit) provides Java compiler and other
2. resources	tools for developing Java applications. ....
3. related topics	
SP cross-platform	{Java is noted for its support for cross-platform software
software development	development. Many Internet applications are written in
	Java.}
Demonstration :	......
My first Java program	Step1. Enter MS-DOS mode,
	Step2. Type in a Java program,
	Step3. Compile and test the program.

Table 1 suggests a taxonomy of video contents by the formats of presentation. There are other ways to classify the same information in a script; e.g., the table of contents of a course or a lesson. No matter which classification scheme is chosen, the content of a script will be structured according to some sort of criteria. The resulting structure leads to reusable content modules. In the design of Web-based content, these modules can easily be organized in hyperlink-style Web pages. In our research, structured script writing follows well-defined style guide which can be specified by the tags' syntax and semantics. In a practical situation, a structured script editor can be used to help follow the rules.

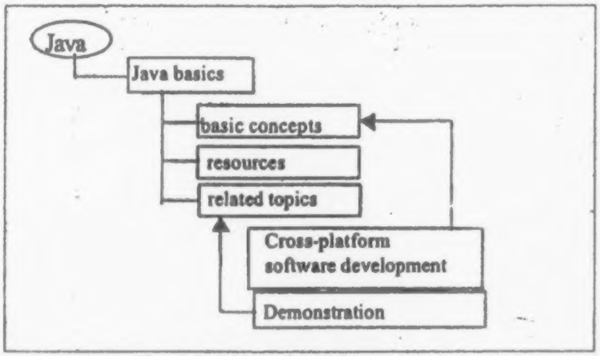


Figure 1. A hierarchy of elements

4 The Process and Methodology

Although TV broadcast still plays a major role in reaching most audience, network-based media have been growing in a pace much faster than traditional media. Since all kinds of media can be digitized and integrated into computer files, there is possibility that video-based instructional media can also be distributed in the form of network-based media. However, the design and production of traditional video-based instructional media has not been guided along this direction. Most existing instructional tapes are not able to function at least as well on the network, not to mention adding learning activities or interaction to these video programs.

Our research is focused on establishing a methodology and a mechanism for producing instructional video that works for broadcast and is able to help learners on the network. We are not aimed to investigate technical details on post-production of digital media. Instead, we are trying to look for answers on the following question, ''what kind of content in what format should be included in instructional videos and how?'' Figure 2 shows an overview of the production process. TV broadcast is more expensive and less flexible than distribution through Web hosts. However, Web access consumes a significant amount of network bandwidth for AV streams. On the other hand, studio production of videos is expensive. In the same professional area, many topics are likely to overlap in different programs. To reduce cost and enhance effectiveness, we can take advantage of studio production of video programs by changing the process of the script stage in a way that finished videos can easily be transformed to Web-ready media. The script stage is critical since later production steps are all based on the finished script.

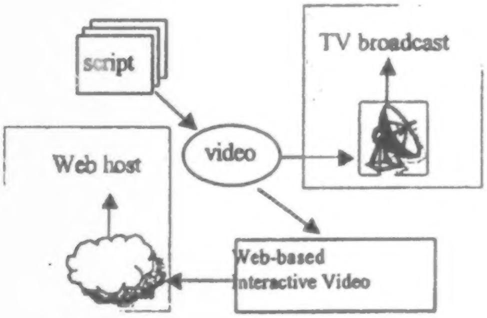


Figure 2. An overview of the production process

In order to achieve optimality among cost and effectiveness factors, there is a need to divide video programs to well-defined units. By well-defined we mean the unit should be complete and self-explanatory. Once the video program is divided into units, Web-based media will be feasible since viewers will not need to download the entire video program. The problem of reproducing the same content can also be avoided since the video unit is reusable. Obviously, the script stage is the most critical step toward a favorable solution. We re-shape the script writing process in the following ways:

1. *Component-based script creation*: Script writers or designers must be able to identify the components appeared in the script. Instead of dividing a script into components, we suggest a practice of component-based design at the beginning. Every component is identified by certain criteria; e.g., topic, presentation format, etc.
2. *Hierarchical planning*: The content of a script comes from a course or a lesson. The structure of the course or lesson is embedded in the script. At the script stage, how the content is divided or inter-related should be planned ahead. Later production of Web-based material will benefit from the pre-built hierarchy. Since the hierarchy is strongly content-specific, content expert should play the key role in this process.
3. *Extended tag set:* Existing notations used in script writing do not provide enough modeling capability for automated partition of structured scripts. We use an extended tag set. Part of the set is listed in Table 4. With this addition, it becomes feasible to develop a software editor for the creation and processing of structured script. The syntax and semantics of these tags are part of the style guide for structured script writing.

Table 4. Extended tag set for script writing

Tag	Usage
STC	The starting point of a topic
TC	Tele-card
SP	Superscription
VC	Video clip
CV	Computer video
CM	Commentary

Once the script is created structurally, studio production can proceed as usual. The next step is to import digital Beta-cam video source onto a post-production workstation. The video source becomes computer files. Since the original structured script contains meaningful tags, we can divide the video file into content modules based on the semantics of these tags. Figure 3 shows that the content modules can then be incorporated in the design of Web pages. These pages may be used and reused in various lessons, courses, and curriculum. There exists a transition between toc (table-of-contents) style and hyperlink style domain-specific contents.

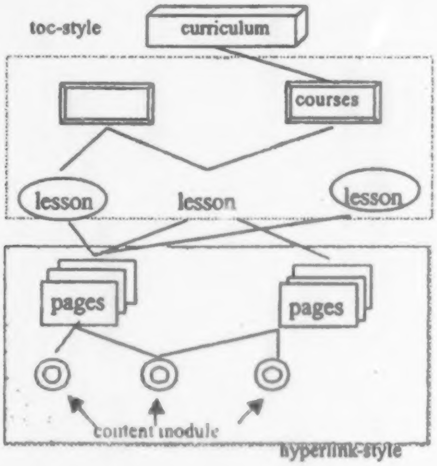


Figure 3. From toc-style to hyperlink style content presentation

The video content modules have no interaction at all. To add interaction to Web-based material, a variety of learning activities can be designed and integrated with various instructional media [6]. Figure 4 depicts the flow of learning activities. Learners start to work on the assignment through the interface of the Web browser. The assignment has been designed to help learners follow a sequence of steps to get result for discussion. The learning process can be evaluated and repeated. After finishing the assignment, learners may perform a test to see their own progress and head to the next assignment. In Figure 4, we can see that the video components produced from structured scripts are used for creating Web-based learning material. With the addition of the interactive design, the original video components are transformed to interactive video.

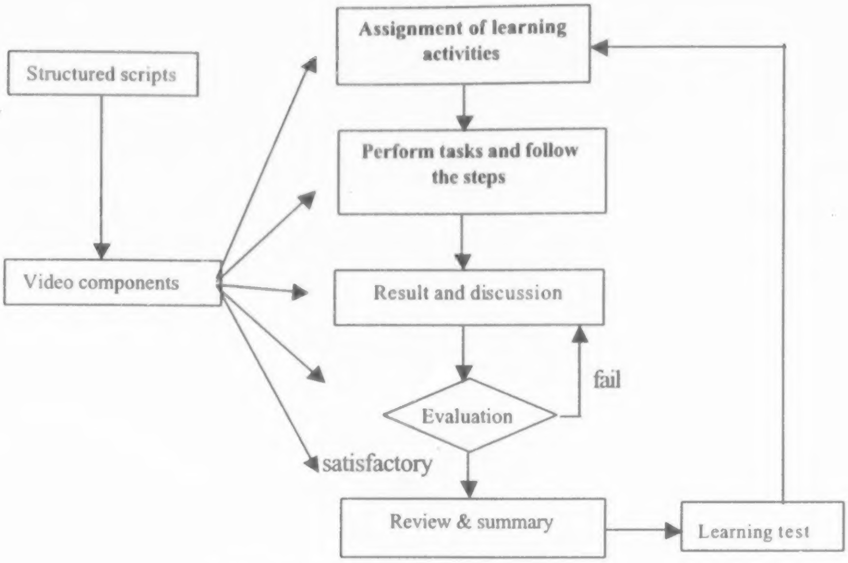


Figure 4. Interactive learning component

5 Experience Report

We choose a computing course, Data Structures, to exemplify the reference model resulted from the research. The reference model describes a formal process for producing instructional video suitable for integration with other digitized instructional media. Feedback and analysis collected from activities and experience of teaching the course is used to explain the strength and weakness of our approach.

1. Learning with interaction provides essential experience for successful learning.
2. Video programs alone are not able to provide required interaction.
3. Structured scripts are helpful for designers of Web-based instructional material.
4. The extended tag set for structured scripts should be clear and easy to use.
5. The reference model needs more instances to exemplify the use of tags, style guide, partition criteria, etc.

6 Conclusions

The learning experience by viewing a video program is different from browsing through a CBT (Computer-Based Training) lesson. However, the video part of both; i.e., traditional video programs and CBTs, may come from the same studio production process. Structured scripts have the potential of making video programs suitable for both TV broadcast and Web hosting. Content experts will take more responsibility on improving the quality and effectiveness of instructional videos. Media experts should carry on to provide assistance on the integration of learning activities with video content modules. Technical staff will then have enough information to build Web-based interactive video and other related learning and instructional material.

References

Burgess, W. E. *The ORYX Guide to Distance Learning*. 2nd Ed. ORYX PRESS, 1997.
Chellappa, R., Barua, A., and Whinston A. B. ``An Electronic Infrastructure for a Virtual University". *Communications of the ACM*, pp. 56-58, 1997.

- Collis, Betty. *Tele-learning in a Digital World : The Future of Distance Learning.* Thomson Computer Press, 1996.
- Eustace, G. *Writing for Corporate Video.* Focal Press, 1990.
- Hall, Brandon. *Web-Based Training Cookbook*. John Wiley & Sons, 1997
- Horton, W. *Designing Web-Based Training.* John Wiley & Sons, 2000.
- McCormack, C., et al. *Building a Web-Based Education System.* Wiley Computer Publishing, 1997.
- Millerson, G. *Effective TV Production.* Focal Press, 1983.
- Swain, D. V. *Scripting for Video and Audiovisual Media.* Focal Press. 1981.

The Rhetoric of the web–A semiotic approach to the design and analysis of web-documents

Jens F. Jensen
InterMedia Aalborg, Aalborg University
Niels Jernersvej, NOVI4-215, DK-9220 Aalborg East, DENMARK
Phone: +45 98 15 62 79 Fax: +45 98 14 24 44
E-mail: jensf@hum.auc.dk

This paper seeks to discuss possible approaches through which semiotics and rhetoric can be applied to the World Wide Web seen as a multimedia; or, in other words, possible approaches through which Web-sites and Web-pages can be studied and designed from a semiotic point of view-The aim of the paper is thus to outline a coherent theoretical, methodological and analytical framework for the study and design of Web-documents based on semiotics and rhetoric. This paper has analytical, theoretical, methodological, as well as practical implications. It is of interest in relation to the analytical and theoretical understanding of the new and rapidly growing web medium, and in relation to methods of examining this phenomenon. The study shows the concepts and categories from the field of semiotics and rhetoric are highly relevant to the area of the web and it indicates that the concepts presented here can form the building blocks for a more general ' Semiotics of Cyberspace'. The observations from this study may also have an effect on conventional theory formation and understanding within semiotics, rhetoric, and communication research and media studies. However, it also has implications for the construction and design aspects since the design of Web-documents and Web-sites must be based on actual knowledge of the conditions and possibilities for communication and the construction of signs, codes and meaning in the new medium.

*The paper was not available by the date of printing.

The Status of Cyber University in Korea and its Future Direction

Wang, Sukhee *, Kim, Youngsil**
Bisan Dong, Dongan-gu, Anyang-Si, Kyungki, Korea
Daelim College of Technolog, Computer Science Dept.
*Tel.: * 82-31- 467- 4882, ** 82-31-467-4884, Fax . : * 82-31-467- 4888*
** e-mail: shwang@daelim.ac.kr, ** e-mail: YSKIM@daelim.ac.kr*

Cyber universities create innovative and more effective approaches to teaching and learning. In Korea, cyber universities are running in many different ways: universities established as an example case designated by Education Ministry, universities opened for life-long education, and cyber graduate school for educating professionals in many fields. Also, cyber campus for college level has started in many technical colleges. In this paper, we study the present status of cyber universities, its critical issues, and direction of its development in Korea. We focus on necessity of cyber universities consortium, allowing students enrolled in traditional universities to take certain amount of credits from cyber classes, and basic requirements for high-quality cyber lectures.

Key Words: **cyber school, cyber university, Interactive learning, Web-based learning**

1 Introduction

Cyber student population is dramatically increasing since the development of information communication technology. Evolution of information technology allows us to learn anywhere, anytime. Since 1988, five universities including Seoul National University have been selected as model case cyber universities, and ten universities including Sogang University as experimental case. According to this policy, Seoul National Cyber University opened four courses in March, 1998. In the first semester of 2000 school year, total of 24 courses were opened.

Some of the model case cyber universities are Bool Cyber University, Open Cyber University, and Seoul Cyber Design University. Also, experimental case universities are Korea Cyber University (KCU) and Information Technology Cyber University, a consortium of 14 universities including Kangwon, Kyunghee, Korea National Open University sponsored by Education Ministry.

Cyber universities for life-long education are Unitel Cyber Campus and Campus 21. Campus 21 was established by Netist, Internet Contents Development Company, in 1998. Now courses in Information Technology field, Foreign Language field, and Programming field are available. [1,3,8]

So far, these cyber universities were not allowed to confer degrees on students. However, since March 2000, cyber universities, permitted from Education Ministry, confer degrees on students by Life-Long Education Law. Education Ministry received application for establishment of cyber university until June 2000. Sixteen cyber universities and one In-company cyber university are now registered.

In this paper, we study the present status of cyber universities, its critical issues, and direction of its development in Korea. We focus on necessity of cyber universities consortium, allowing students enrolled in traditional universities to take certain amount of credits from cyber classes, and basic requirements for high-quality cyber lectures.

2 Present Status

Cyber universities program delivers unparalleled convenience and flexibility in the pursuit of their bachelor's, master's and professional bachelor's degree. They also offer customized training programs and reeducation programs for employees to many of the corporations. In Korea, the cyber universities and the courses they offer are increasing, and many of the students are willing to attend cyber universities due to their cost and time reduction, higher retention rates and self-paced training and performance support. Now, we would like to introduce some desirable cases.

2.1 KCU (Korea Cyber University)

KCU is the first cyber university consortium of 37 universities including Hanyang, and Younsei University, sponsored by Chosun Daily News, and Digital Chosun. In the first semester of 1999 school year, there were 507 classes, 25,389 students enrolled in, in the following semester, 706 classes, and 41,293 students. Korea Cyber Universities are planning to open classes to the public so that the students can pursue their degrees online. [3]

2.2 OCU (Open Cyber University)

OCU, selected as the designated institution from the Education Ministry in February 1998, is composed of 14 participated universities five cooperating universities, and 3 organizations. The 444 courses have been offered until first semester 2000. In fall semester 2000, 244 courses will be opened. [10]

2.3 Information Technology Cyber University

Consortium of 15 universities is take part in IT Cyber University. Total 26 multimedia lecture contents are completed including 12 internet technology courses, 2 IT general courses, 6 web based multimedia courses, and 4 IT venture classes. [4]

2.4 Namhae College

Inside NAMHAE Cyber Academy, there are cyber lecture room, broadcasting room, discussion room, chatting room, on-line evaluation room. And also, graphic file and audio lecture files are available. 345 classes have been offered so far, 1st semester in 2000, 84 courses were opened. [5]

2.5 Present Status

The Education Ministry has received 16 applications to launch degree-offering cyber universities, which are set to open March 2001, for the first time in Korea. By the June, 2000 deadline, four consortia of universities, eight individual universities and four private groups submitted applications to operate institutions offering courses on the Internet. Thirteen of them applied to provide bachelor's degrees, while the remaining three wanted to open courses for junior college diplomas. According to their submitted plans, the 16 applicants would recruit a combined total of 15,800 students in 81 departments. Samsung Electronics applied to set up an in-house college program for its employees. Samsung's plan envisages establishing a "Samsung Semiconductor Institute of Technology" that would offer a four-year bachelor's degree program and a two-year diploma course on digital and display engineering. It would be the nation's first accredited institution of higher learning set up exclusively for employees of a specific company. Education Ministry is planning to finish screening the applications by November, 2000.

3 Critical Issues

Cyber university hold great promise for enriching educational opportunity, especially for the homebound, or geographically isolated students. However, these advantages are overshadowed by many concerns.

3.1 General Aspects

∗For cyber universities are at the point of beginning, law, technology, management system and marketing strategies are not yet fully established. Therefore, students don't have confidence in getting degrees.
∗In cyber universities, there is lack of opportunities meeting professors face-to-face.
∗Many of the students who have low-speed modem, spend lots of time to downloading lecture materials. When the lecture is transferring, time delaying is the most critical problem for real-time question and answer.
∗For the cyber students don't have opportunities to meet other classmates or professors, the students don't have a chance to have social relationships, and get personality and ethics education.
∗Due to the expanding of cyber universities, the traditional education system, which have played a great role in our history, is threatened. So, it is important to maintain balance of both education system.
∗Lack of fund for developing high-quality multimedia contents and running cost is the biggest problem. In 1999, for example, the Information Technology Cyber university spent $2million for developing 26 multimedia lecture contents (about $50,000 per course).

Cyber school will develop innovative and more effective approaches to teaching and learning. It will meet these objectives by creating a collaborative group of faculty who, with technical support, will work together to discover what online technologies are available, to determine how they can be used to transform the educational experience, and to assess their teaching effectiveness.

This ongoing collaborative effort will result in continuing faculty professional development and a transformation in how students are taught. [6,7]

3.2 Faculty and Student Aspects

∗For faculty in Korea, developing courseware and teaching takes too much time. So, they feel over-burdened on developing courseware and preparing lectures. In Korea, professors are obliged to teach for at least nine hours a week. However, in the case of Information Technology Graduate Cyber School, the professors are obliged to teach for three hours(one course) a week.
∗It is hard for faculties to teach due to the diversity of student level. Also, it takes too much time to grade student's reports and quizzes. So, many teaching assistants should be available.
∗Students have difficulties in course registration, dropping, adding and changing. [12,13]. In addition, it is hard for students to adapt due to the differences of platforms.
∗Lack of interactiveness for intellectual motivation, and debating opportunities might result in passive participation for students. Moreover, flexibility of lecture schedules for employed students are not usually available.

4 Future Direction

Cyber campus must create an academic milieu that empowers the professional growth of faculty. The Cyber school must also create innovative and more effective approaches to teaching and learning. To implement the above objectives, the Cyber school will accomplish the followings.

∗Testing: Exams should be available for each course.
∗Feedback: immediate feedback provides each student with the topics they need.
∗Security: Cyber university delivers all this safely and securely.
∗Academic faculty must maintain control of shaping, approving and evaluating distance- education courses.
∗Faculty should be compensated and given time, training and technical support to develop and conduct classes, and they should retain intellectual property rights over online materials.
∗Students must be given advance information about course requirements, equipment needs, technical training and support throughout the course.
∗Students should have opportunities to meet professors face-to-face whenever feasible.
∗Full undergraduate degree programs should include classroom-based coursework.
∗Quality of graphic resolution for multimedia files.
∗Chattingroom in which professors and students are involved should be offered.
∗Proper feedback for reports and projects should be offered.

- ∗Online evaluation room and discussion room should be made.
- ∗Shortening the time used for downloading the lectures should be considered.
- ∗In classes offered by consortium, it should include high quality of contents, and the video will at least include 30% of the lecture. Also, in-class teaching (face to face) should be required at least twice a semester.
- ∗Especially for college level, there are two ways of getting involved in cyber campus. First, students can take 80% of their credit at school and other 20% at any other cyber college. Second is allowing the students to take certain amount of cyber classes. This is for the students who have jobs during the day, for there are many difficulties attending the classes for them. Eventually, it will not only benefit in time reduction but also in higher retention rates.
- ∗For developments of these high-quality cyber class contents and efficient operation, supporting of funds, technologies, software, and hardware is urgently needed.
- ∗Cost and time reduction to develop multimedia lecture contents. New courses should be added regularly to give users access to the most current application and topics.
- ∗Higher retention rates: Cyber university offers content in the form of interactive multimedia, users learn faster and retain more information.

Cyber school will develop innovative and more effective approaches to teaching and learning. It will meet these objectives by creating a collaborative group of faculty who, with technical support, will work together to discover what online technologies are available, to determine how they can be used to transform the educational experience, and to assess their teaching effectiveness.

This ongoing collaborative effort will result in continuing faculty professional development and a transformation in how students are taught.

5 Conclusion

The possibilities of cyber universities are endless as educators and students alike enthusiastically tout the convenience and advantages. But many professors worry about the accelerated pace and are trying to place some brakes on the race.

One-million member American Federation of Teachers, which includes about 110,000 college and university professors, approved at its Philadelphia convention a resolution calling for a set of quality standards for college-based distance-education programs. [2] Of course, it is critical that we hold this kind of programs to a high standard of academic rigor. However, We need to keep basic requirements to maintain high quality cyber lectures and student level. And also, government funding, technical equipment's, hardware/software supporting from the company, and tele communication infrastructure should be maintained.

References

Most of the internet site accessed on at the end of June to the beginning of July, 2000).
[1] Radford University http://www.runet.edu/~cyberu/intro.html
[2] Applied Technology Partners http://www.atpcorp.com/exam/university.html
[3] Korea Cyber University http://www.chosun.com/class/koreauni1.html
[4] Information & Communication University http://cyber.icu.ac.kr
[5] Namhae College http://www.namhae.ac.kr/infomanager1/main2.htm
[6] Kwak, Dukhoon (2000), "Management of Cyber university -Case Study: Information Technology Cyber University", Schoolnet 2000, Proceedings, PP.276-284
[7] Lee, Dongman, "Information and Communications University: Cyber Lecture", Schoolnet 2000, PP.400-408
[8] Campus 21 http://www.campus21.co.kr/home/default.asp
[9] Internet Library http://www.peacenet.net/english/internet/trend/1.htm
[10] Open Cyber University http://www.ocu.ac.kr/open_menu/introduction/default.htm
[11] Dongui Cyber University http://www.dit.ac.kr:82/menu6.htm
[12]"Integrated Information Services for 21st Century Education", June, 2000, Choongchung College
[13]"The Direction of Development for Integrated University Information System", Invited Seminar Proceedings, June 2000, Korea Info-Tech Co.

Tracking and Guiding Tools for Learning Groups in a Web Collaborative Learning System

Kuo-Liang Ou, Chen-Chung Liu, Jiun-Ren Huang, and Gwo-Dong Chen
Department of Computer Science and Information Engineering
National Central University
Chung-Li TAIWAN 32054
Tel.: +(886)3-4227151ext 4504 Fax.: +(886)3-422-2681
Email: klou@db.csie.ncu.edu.tw

Owing to prevent a learning group from failing, teachers need to observe the group learning situation, and discover its causal dependence in a web collaborative learning system. Therefore, teachers need to record the web logs and try to analyze these row data. However, the web logs amounts are often exceeding the teachers' readability and becomes to be meaningless. This work presents some assisting tools of Bayesian belief network supported another window to observe the leaning situation objectively, and predicts the probability of the learning situation before the end of semester. This work was experimented on managing a web collaborative learning with 706 students online. The results represents these tools relieved the teacher of tedious data collection and analysis, analyzed the causal dependence of each learning features, discovered the hidden learning features related with the social interdependence, and prevent the students learning from failed.

Keywords: **Bayesian Belief Network, Collaborative Learning, Learning Features, WWW**

1 Introduction

In existing web learning systems, students may feel lonely without learning companions. Many researches have indicatethat students will learn better when they learn in a group [1] [2] [3]. Thus, the group learning mechanism can be adopted into web learning to overcome the lonely study issue. A web collaborative learning system requires the teacher to put lots of efforts in tracking and guiding these groups on the web. It is difficult for teachers to capture the group learning status from the huge amount of unorganized web logs. The situation is even worse when hundreds of students are involved in collaborative learning, and it is difficult to get information from them [16]. Therefore, many assisting tools for analyzing the web logs were developed. [4]

However, most of these tools focused on providing summary of how the website is being accessed, for example, the statistics of access time, access frequencies, and the access location of web page. In fact, these numeral results and statistics are not enough for a teacher to obtain the status of learning groups in a collaborative learning system. Teachers ask for information to help them promote the collaborative learning performance. Example information includes whether a group leader success in fulfilling her/his role; whether there is distrust existing among group members, and low perceptions of help and assistance [5].

Moreover, a teacher needs information to track the social interdependence of a learning group. Johnson [1] identified that *social interdependence* is a key factor that affects the success of learning groups. The *social interdependence* includes the goal, reward, resource, role and task interdependence. The problem is these impact factors cannot be captured directly by analyzing access logs. Furthermore, the inter-group communication context is not apparent. Therefore, it is a challenge for a teacher to obtain the status of these impact factors immediately when tracking and guiding a web collaborative learning system.

Once the impact factors of a web collaborative learning is detected, the graphical model for representing the causal relationships is required for teachers to make a decision to teach strategies and intervene groups' learning online. In order to preventing a group from failing in the early semester, an appropriate invention is needed. After constructing such causal map for several times, teacher will accumulate some experiences of how to prevent groups from failing in time. However, this kind of individual experience is not reusable for other teachers or teaching assistants.

There we summarized two issues mentioned above when teachers try to manage the web collaborative learning.

- Discover the impact factors of learning situation:
  Since the social interdependence affects the collaborative learning deeply, teacher need some assisting tools to find out the impact factors hidden in web logs and group portfolios.
- Prevent groups to be failed by experience analysis:
  At the end of semester of a collaborative learning, the experience and logs could be an important reference for the next semester. If teacher could find out the impact reason of specific states, her/he could prompt the group to learn or prevent the group from failing.

To resolve the issues listed above, our research tried to employ some data mining techniques and supported some useful information for teachers to manage the web collaborative learning.

The participators in this research included 7 teachers, 5 teaching assistants and 706 students. All of these participators teaching and learning via video compacted disc (VCD), and collaborated the group works and discussed to members on web. Students were divided into 2 classes: Class-A and Class-B. Both classes were used the same teaching strategies and curriculums. In this research, the learning logs of Class-A were used for constructing the relational map between each learning feature. It was the simulated past-experience for predicting the learning states of Class-B. The result shows that with the assistance of these useful tools, teacher could track and guide the web collaborative learning with meaningful learning states, discover the impact factors associated with the social interdependence, and predict the learning state and make a teaching decision online.

2 The Bayesian Believe Network

This work employed the Bayesian belief network (BBN) [6] to model the learning situations and represented the causal relationship between these situations in a graphical map. The BBN is a directive map composed by some nodes and arcs, these nodes and arcs represent the joint probability distribution for a set of variables. In this research, the nodes represent the group's *Feature Space (FS)* [7], and the arcs represent the relationship and the joint probability of two FS. It is named as "FS-based Bayesian belief network (FSBBN)". In Figure 1, it is an example for illustrating the FSBBN of a web-based collaborative learning: the "Learning Failed" node represented the group grade less than 60 at the final of semester. The "Homework Late Submitting" node represented the group homework were submitted after the deadline. The "Less Discussing" node represented the discussion amount in discussion place were less than 3 post each day. The "Less Login" node represented the average login times of a group less than 1. The "Leader Failed" node represented the group leader were failed in his jobs. The arcs in BBN represented the causal relationships between each node, and were constructed by the Bayesian Classifier. The Bayesian Classifier figured out the probability of each node that was affected by the previous nodes.

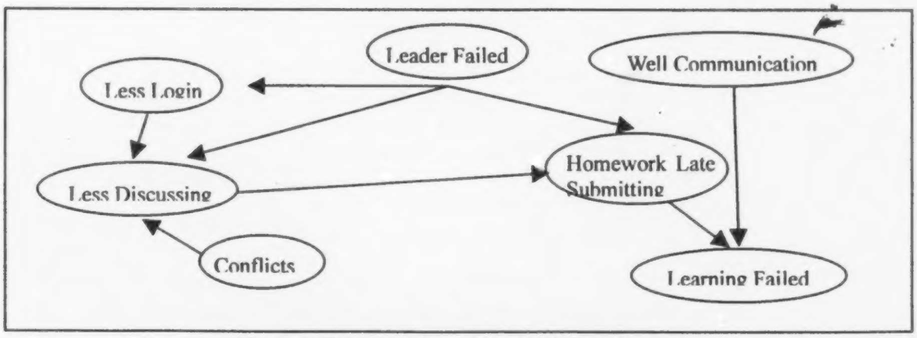


Figure 1: The example of Bayesian belief Network

Some probability tables deducted the directive arcs in FSBBN. Table 1 presents the probability of "Learning Failed" of a group, where "Learning Failed" is abbreviated to F, "Homework Late Submitting" is abbreviated to H, and "Well Communication" is abbreviated to W. The direct effects of "Learning Failed"included the probability of "Well Communication" and "Homework Late Submitting" both. Moreover, the direct effects of "Homework Late Submitting" included the probability of "Leader Failed" and "Less Discussion". In this way, the effects of "Learning Failed" included the probability of "Well Communication", "Homework Late Submitting", "Less Discussion", "Less Login", "Conflicts and Leader Failed".

	H,W	H,¬W	¬H,W	¬H, ¬W
F	0.35	0.93	0.02	0.54
¬F	0.65	0.07	0.98	0.56

Learning Failed

Table 1: The probability of Learning Failed

The FSBBN makes assistance for teachers finding out the relationships between each learning FS. It also supported the need for teaching decision in a web-based collaborative learning system, and will be illustrate in the following chapters.

3 Applying the Data Mining Tools in Learning Tracking and Teaching Guidance

To track students' learning status, teacher must to obtain the relationships between each impact factors of collaborative learning. In this chapter, several BBN tools support a directive map that illustrate these FS and help teachers to discover the objective causal relationships between these FS. These causal relationships support teachers to make a decision and promote the group to learn, prevent the group to be failed at the end of semester. This chapter will introduce some of free-wares and show how to apply these public tools in constructing a FSBBN and managing a web-based collaborative learning.

3.1 Observing the collaborative learning states and find out the impact factors

Bayesian Knowledge Discoverer (BKD) is noncommercial classification software for research, released by Knowledge Media Institute of Open University of UK. [8]. The aim of BKD is to provide a Knowledge Discovery tool able to extract reusable knowledge from databases, without expecting any particular methodological background from the user. To this aim, BKD uses BBN as a graphical representation of the dependent model in the database. Once the BBN generated from data, the network can be used as a self-contained reasoning system, able to provide observation, predictions and support decision making for a teacher.

The BKD needs a text file exported from database for constructing the BBN. The input data could be numeric or discrete data. To generated the complete causal network of a web collaborative learning, the input data of BKD should include the learning FS, personal profiles, online access statistics collaborative portfolios, and discussion situation. In Table 2, it illustrated that the teachers' interesting items about the learning situations. There are two groups of items: (1) learning FS (2) online statistic. All the values in this group were discrete Yes/NO or a label of level. The other items in second group were the online statistic from database, including the students' profiles, web accessing and discussion.

In Table 2, the "Conflict" means if the members have ever conflicted on the project goal with members, it represented the goal independence of a group. The "Lack Leadership" means the group leader failed in her/his role, it represented the leaders' role independence. The "Poor Comm" means the members made the communications with others rarely on the issues of project. The "Distrust" mean students have low trust with members about the discussion content and sharing resource, both of above FS represented the resource interdependence of a group. The "Poor Help" means if members did not like to help others in collaborative project, it represented the reward independence of a group. The "Query Work" means the number that member query the current result of group project. It represents task interdependence of a group. Finally, the "Lower Grade" means the group failed in learning and got lower grades.

Group Id	Conflict	Lack Leadership	Poor Comm	Distrust	Poor Help	Query Work	Disc Online	Email	Disc Lonely	Lower Grades	...
1	N	N	Y	N	N	64	6	6	48	Y	
2	Y	N	Y	N	N	165	4	21	14	N	
3	Y	Y	N	N	Y	0	0	13	19	Y	
4	N	N	N	N	N	44	3	19	13	N	
5	Y	N	Y	N	N	196	4	26	25	N	
6	Y	N	N	N	N	198	57	6	170	N	
7	Y	N	Y	Y	N	91	4	27	33	N	
8	Y	N	Y	N	N	175	3	6	41	N	
9	Y	Y	Y	N	N	68	1	8	16	N	
10	N	N	Y	N	N	70	7	13	23	Y	
...											
35	Y	N	Y	N	Y	12	2	3	15	Y	

Table 2: The input file for BKD (Class A)

After the input file import into the BKD, the system will construct a FSBBN for teachers to observe the relationships and the probability model for decision-making, like the example in Figure 1.

3.2 Experience reuse to prevent groups to be failed

To prevent groups to be failed early, the teacher would like to predict the group's learning state at the end of semester by the current states and her/his past teaching experience. The ideal to predict the learning states is to classify the new FS into the classes divided by the past FSBBN. In traditional classification tools, it contains two steps for prediction: first the system is trained by teacher's experience on a set of past data. The second, system will classify the cases by the trained set. The Robust Classifier (Roc) [8] is also noncommercial classification software for research, released by the Knowledge Media Institute of Open University of UK. It supports an efficient tool for teachers to classify the past FS into several classes, and predict the new FS into these classes.

There are four steps of Roc to predict a set of real-time FS illustrated as follows:

1. Define the Bayesian classifier from a database:
2. Class selection and discretization:
3. Learning the past learning FS:
4. Predictions the real-time FS:

There is an example how a teacher using the four steps to prevent the group learning failed:

Step1. Collecting the learning FS and online access data as the input file. Table 2 illustrated the teacher collected the input data of Class A for constructing the classifier. The input file has the same file format as the input file for BKD system.

Step2. Select one of the FS of input data as the class. For example, the teachers are interesting to obtain which group with the real-time FS will get lower grade at the end of semester.

Step3.After the Roc learning procedure proceed in this step, it generated the probability of each FS to the selected classes (Lower_Grades). In Table 3, two of FS: "Conflict" and "Leader_Failed" was listed and illustrate the probability of the group to be failed and get lower grades (Lower_Grades)

Step4. Predict the probability of learning failed via the online data of Class-B. Although Class-A and Class B were hold at the same semester, for prove the ability of prediction in this paper, the online FS of Class B were used as the test data. In case of the prediction were hold before the end of semester, some data were absent until the end of semester when predicting. In this research, several FS of Class-B were marked as '?' for simulating this situation.

```
Class Lower_Grade
N Y                      Attribute Conflict                         Attribute Leader_Failed
(0.690 ) (0.310 )                              Y          N                                   Y          N
                          N              (0.621 )  (0.379 )      N                   (0.172 )  (0.828 )
                          Y              (0.385 )  (0.615 )      Y                   (0.231 )  (0.769 )
```

Table 3: The results of Roc learning procedure

In Table 4, the coverage shows all the cases of Class B are predictable in RoC. The column "Lower Grades" is the original FS of Class B. It must be noted that in a real life case, this value of "Lower Grades" of Class B will not be known until the end of semester. The column "Predicted Result" is predicted by RoC with the input data in and the learning data. It is clearly that the system predicted group 1 would not get a Lower Grades at the end of semester. And the fact matched this prediction. However, the prediction of group 2 mismatched the fact. The column "Probability" represents the probability of such predictions of each group. In this experiment, the predicted result showed that the accuracy is 77.77% (28 correct, 8 incorrect). This credible result of RoC provides teachers not only predict the probability of each group to be Lower Grades, but also all other FS groups of social independence and will be discussed in next chapter.

Group id	Predicted Result	Lower Grades	Probability
1	N	N	0.561
2	N	Y	0.977
…	…	…	…
36	Y	Y	0.897
Correct:	28		
Incorrect:	8		
Accuracy:	77.77 %		
Coverage	100.0 %		

Table 4: The output file of predicted result (Class B)

4 Experience and Result

In this chapter, teachers exhibit a web-based collaborative learning on the "Introduction of Computer Network and Applications" course. The data mining tools such as BKD and Roc were employed and help teachers to observe the learning states, intervene the learning to promote collaborating and illustrated the ability to prevent the group to be fail before the end of semester.

4.1 The participants and the grouping on web

The participators included 7 teachers, 5 teaching assistants and 706 students in Taiwan. The 63% of students are teachers in high school, and all graduated form colleges or above. The 706 students were divided randomly into tow class named Class-A and Class-B. After the first month for students to be used to the environment, functions and operations, students were grouped into several heterogeneous groups by the grouping tools [9]. The grouping criterion included the personal profile and thinking style [10]. There were 35 groups in Class-A and 36 groups in Class-B, average 9.9 students in a group. The 63.5% of students are also the teachers in high school and all graduated from college or above. It represents most of the students did not have the difficult to get on-line. The students read the curriculums from video compacted disc (VCD). After the reading work, students must register in the NCUVC [11][12][15] collaborative learning system. The NCUVC support a web discussing space, collaborative project space and sharing resource in space, etc. The first group task is to elect the cadres, included the leader, co-leader and the clerk, and check-in the group private working space. The group private working space supported the online and offline discussion room, a resource sharing space, a portfolio space, a project scheduler, and a window for querying the member working states.

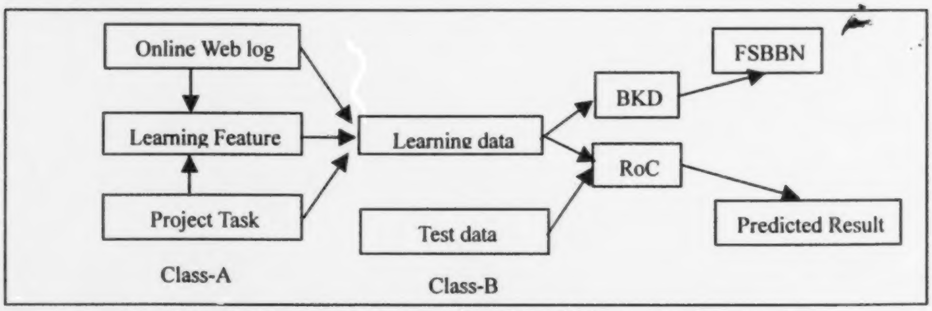


Figure 2: The process for observing and predicting the learning situation

Figure 2 illustrates the process for teachers to observe the learning FSBBN and predict the learning situation. For observing the learning states, teachers collected all the online/offline data to be the learning data and the input data for BKD system. The output of BKD is the form of graphical FSBBN. For predicting the learning situation of Class-B, teacher employed the training data to be the first input data of RoC system. The online data of Class-B is the test data and second input data of RoC. The result classified the cases of Class-B into the classes of Class-A, and support probability of each class for teachers.

4.2 Observe the learning states

After all the groups were ready to work together, teachers assigned the first project to each group. It is a collaborative project for constructing the web site for teaching the techniques of web programming. In the progress of project, teacher would like to observe the learning and working states of each group. There two type of observing method supported NCUVC. First, the subjective FS: teachers could construct the FS subjectively and focus on the specific group learning/working states, which are interesting for individual teacher. Because different teachers will define different FS for each group, it is the subjective observing tool dependent on teachers. Second, the objective FSBBN: it is a causal map based on the FS and all the accessing logs on web, the BKD system will construct the FSBBN for each group. Therefore, teachers could track the learning states and the causal relationships between each FS and access log. Because the causal map was constructed by the Bayesian method, it support the objective observing tool. The following figure is an example for observing the learning Class-A.

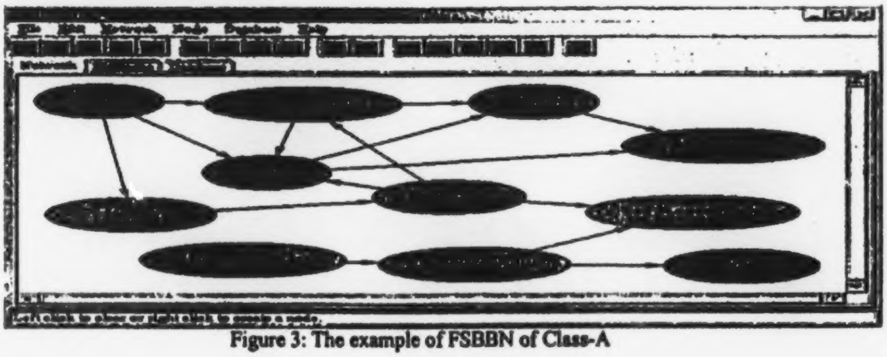


Figure 3: The example of FSBBN of Class-A

In Figure 3, teachers were interesting the causal relationships of homework grades (Hw_Grade) of each group. This FSBBN illustrated that the homework grades were influenced by the complete rate of homework (Complete_Rate). The BKD also figured out the probability of each level of Complete_Rate (high,mid,low) and the level of Hw_Grade(good,general,poor). It was illustrated in the following table.

Grade / Complete_Rate	Good	General	Poor
High	0.956	0.022	0.022
Mid	0.006	0.990	0.004
Low	0.028	0.042	0.930

Table 5: The probability of Complete_Rate and Hw_Grade

It is clearly that the group with higher complete rate, it has higher probability (0.956) to get good grade at the end of semester. In contract, the lower complete rate has higher probability (0.930) to get poor grade. Thus, teachers could observe the causal relationships of each learning features with the help of FSBBN.

4.3 Discover the causal relationships between FS and social interdependence

The social interdependence exists when the outcomes of individual are affected by each other's action [1] [13]. It plays an important role for the success of a collaborative learning. However, teachers have difficult for observing the social interdependence without face-to-face interaction on web. In this chapter, all the social interdependence was transformed into the form of FS and the FSBBN, these representation could be a window for observing and predicting the level of social interdependence. With the categories made by Johnson's *Interdependence Typology* [1] the five type of *positive interdependence* must be discussed first. The next table illustrated the web collaborative learning FS related to John's positive interdependence. Johnson's positive interdependence was not evident These FS were classify by teachers' subjectivity

Positive Interdependence	Feature Space
Goal interdependence	Goal_discuss, Query_group_portfolio, Query_members_work, ...
Reward interdependence	Grades, Help_members ,Answer_discussion,...
Resource interdependence	Discussing, Upload_resource, Query_resource, ...
Role interdependence	Allot_task, Leader_failed, Individual_responsibility, ...
Task interdependence	Portfolio, Query_scheduler, ...

Table 6: The associated feature space for observing the positive interdependence

However, some FS associated with these positive interdependence was hidden and not listed in the teachers' subjective FS. The Bayesian method could discover these *missing data* [14] and the causal relationships. In this experiment, teachers tried to collect all the web logs and the result of questionnaires, transformed these data into 70 FS as the input file of BKD. The BKD could discover the missing related FS associated with this social interdependence. First, teachers classified the groups into two classes: goal interdependence and poor goal interdependence. The new class was added into the system as the new FS and named as "Goal_Interdependence". Teachers could selected all the FS or a set of FS including the new FS as the input data of BKD. After the analysis of BKD, the new related FS associated with "Goal_Interdependence" could be discovered in the FSBBN.

4.4 Prevent the group to be failed

In chapter 4, the Roc system supported the credible prediction for the FS of Class B with the experience of Class A. In this experiment, the correct rate is 77.77% is good enough for a teacher to prevent the group to be failed. In fact, some irrelative learning data will reduced the correct rate. For saving time and increase the correct rate of prediction, teachers would like to migrate the redundant FS and remain the necessary FS. The issue is which FS should be migrated and which FS should be remained? The positive interdependence supported a good idea about this issue. In Table 7, teachers tried to predict the probability of learning failed (Low_Grades) with different FS associated with the positive interdependence.

Learning data	Correct Rate of Prediction
Goal interdependence FS	100%
Reward interdependence FS	88.89%
Resource interdependence FS	88.89%
Role interdependence FS	66.66%
Task interdependence FS	86.11%
All the FS	77.77%

Table 7: The correct rate of prediction with different type of FS learning data

The result illustrated that teachers selected different part of FS related with the social interdependence and improve the correctness of prediction. It is interesting that in this experiment, the FS related with goal interdependence has the most dependent relationship with the group grades. The FS related with role interdependence has the least dependent relationship with the group grades. Therefore, teachers could observe the goal interdependence FS at next semester to prevent the group from being failed. Teachers could not only predict the fail probability of a group, but also predict any FS with the subset of all the FS in this system.

5 Conclusion

To assist a teacher in tracking and guiding a web collaborative learning this work has presented the assisting tools for observing the group states, discovering the impact factors of learning situation, and reuse the experience to predict the learning state. The Bayesian method supports an efficient way to achieve these purposes. Without the proposed mechanisms, a teacher must spend considerable time in trying to analyze situation from huge amount of unorganized web logs. The causal relationships of learning situations were hard to track. To predict the learning situation depended on teacher's individual experience that is imprecise and could not be reused for other teachers. This work (1) transformed the huge amount of meaningless web log into the form of readable and meaningful feature space, (2) supported the graphical FSBBN for observing the learning states and discovering the hidden impact factors of web collaborative learning, (3) predicted the learning situation successfully before the end of semester with the online learning situation and experience of past semester.

Observation and tracking the group's learning situation help teachers determine instructional strategies and group's learning performance. With the advantage of feature space and FSBBN, teachers can observe learning performance and analyze the influence of learning situations. The learning space is constructed as a hierarchical graph and teachers can define features for themselves via the instructional domain knowledge, doing to easily and meaningfully. The FSBBN illustrated the causal map of learning situations. With the past experience of tracking and guiding, teachers could predict the learning situation before the end of semester. Therefore, teachers could intervene the group learning to prevent the group from being failed.

Finally, the experiment result demonstrates that teachers' tracking and guiding a web collaborative learning with 706 students were successful and efficient.

Acknowledgement

The authors would like to thank the National Science Council of the Republic of China for financially supporting this research under Contract No. NSC88-2520-S-008-002.

Reference

[1] Johnson, D.W., and Johnson, R.T. "Learning together and alone" (33rd ed.). Egnlewood Cliffs, NJ: Prentice Hall

[2] Collis, B., Andernach, T., & Van Diepen, N. "Web Environments for Group-Based Project Work in Higher Education". International Journal of Educational Telecommunications. No.3 Vol.2 pp.109-130.

[3] Shotsberger, P.G., Smith, K.B., & Spell,C.G. "Collaborative Distance Education on the World Wide Web: What Would That Look Like?", Proceeding of CSCL, 1995. pp.312-316

[4] Zaïane O., Xin M., and Han J. "Discovering Web Access Patterns and Trends by Applying OLAP and Data Mining Technology on Web Logs". ADL 1998: 19-29

[5] Adams, D.M. and Hamm, M.E. "Cooperative Learning, Critical Thinking and Collaboration Across the Curriculum". Charles C Thomas Publisher, 1990

[6] Gertner, A.S., Conati, C., VanLehn. K. (1998). Procedural Help in Andes: Generating, Hints Using a Bayesian Network Student Model. AAAI/IAAI 1998: 106-111

[7] Ou, K.L. Chen, G.D., Liu, C.C., and Liu, B.J "Instructional Instruments for Web Group Learning Systems : The Grouping, Intervention, and Strategy" Proc. The 5th Annual Conference on Innovation and Technology in Computer Science Education, 2000

[8] Ramoni, M. and Sebastiani, P. "An introduction to the Robust Bayesian Classifier". KMI Technical Report Kmi-TR-79, Knowledge Mddia Institute, The Open University, Milton Keynes, 1999

[9] Chen, G.W., Ou, K.L., and Liu, C.C. "Instructional Instruments for Grouping, Intervention, and Strategy Analysis on Web Group Learning Systems". Proc. International Conference on Compters in Education 99, Chi-ba, Japan. (October, 1999)

[10] Sternberg, R. "Thinking Styles" ,Cambridge University Press.

Gertner, A.S., Conati, C., VanLehn. K. (1998). Procedural Help in Andes: Generating, Hints Using a Bayesian Network Student Model. AAAI/IAAI 1998: 106-111

[11] Ou, K.L., Chen G.W., and Liu,B.J. "A Group Learning Environment in a Virtual Classroom Built on WWW". Proc. 6th International Conference on Computer Assisted Instrution, 1997

[12] Liu, C.C., Chen, G.W., Ou, K.L., Liu, B.J., and Horng, J.T. "Managing Activity Dynamics of Web Based Collaborative Applications". International Journal of Artificial Intelligence Tools, Vol. 8, No. 2

[13] Webb, N.M. "Peer interaction and learning in small groups". International Journal of Educational Research, 13(1), pp. 21-29.

[14] Little, R.J.A. and Rubin, D.B. "Statistical Analysis with Missing Data". Wiley, New York.

[15]Ou, K.L., Chang, C.K., & Chen, G.D."Web-based Asynchronous Discussion System". Internatinoal Conference on Computers in Education 1998.

[16] Chang, C.K., Chen, G.D., Ou, K.L., & Liu, B.J. "Student Portfolio Analysis for Decision Support of Web-Based Classroom Teacher by Data Cube Technology". ED-MEDIA/ED-TELECOM 98

Tracking and Guiding Tools for Learning Groups in a Web Collaborative Learning System

Kuo-Liang Ou, Chen-Chung Liu, Jiun-Ren Huang, and Gwo-Dong Chen
Department of Computer Science and Information Engineering
National Central University
Chung-Li TAIWAN 32054
Tel.: +(886)3-4227151ext 4504 Fax.: +(886)3-422-2681
Email: klou@db.csie.ncu.edu.tw

Owing to prevent a learning group from failing, teachers need to observe the group learning situation, and discover its causal dependence in a web collaborative learning system. Therefore, teachers need to record the web logs and try to analyze these row data. However, the web logs amounts are often exceeding the teachers' readability and becomes to be meaningless. This work presents some assisting tools of Bayesian belief network supported another window to observe the leaning situation objectively, and predicts the probability of the learning situation before the end of semester. This work was experimented on managing a web collaborative learning with 706 students online. The results represents these tools relieved the teacher of tedious data collection and analysis, analyzed the causal dependence of each learning features, discovered the hidden learning features related with the social interdependence, and prevent the students learning from failed.

Keywords: **Bayesian Belief Network, Collaborative Learning, Learning Features, WWW**

1 Introduction

In existing web learning systems, students may feel lonely without learning companions. Many researches have indicatethat students will learn better when they learn in a group [1] [2] [3]. Thus, the group learning mechanism can be adopted into web learning to overcome the lonely study issue. A web collaborative learning system requires the teacher to put lots of efforts in tracking and guiding these groups on the web. It is difficult for teachers to capture the group learning status from the huge amount of unorganized web logs. The situation is even worse when hundreds of students are involved in collaborative learning, and it is difficult to get information from them [16]. Therefore, many assisting tools for analyzing the web logs were developed. [4]

However, most of these tools focused on providing summary of how the website is being accessed, for example, the statistics of access time, access frequencies, and the access location of web page. In fact, these numeral results and statistics are not enough for a teacher to obtain the status of learning groups in a collaborative learning system. Teachers ask for information to help them promote the collaborative learning performance. Example information includes whether a group leader success in fulfilling her/his role; whether there is distrust existing among group members, and low perceptions of help and assistance [5].

Moreover, a teacher needs information to track the social interdependence of a learning group. Johnson [1] identified that *social interdependence* is a key factor that affects the success of learning groups. The *social interdependence* includes the goal, reward, resource, role and task interdependence. The problem is these impact factors cannot be captured directly by analyzing access logs. Furthermore, the inter-group communication context is not apparent. Therefore, it is a challenge for a teacher to obtain the status of these impact factors immediately when tracking and guiding a web collaborative learning system.

Once the impact factors of a web collaborative learning is detected, the graphical model for representing the causal relationships is required for teachers to make a decision to teach strategies and intervene groups' learning online. In order to preventing a group from failing in the early semester, an appropriate invention is needed. After constructing such causal map for several times, teacher will accumulate some experiences of how to prevent groups from failing in time. However, this kind of individual experience is not reusable for other teachers or teaching assistants.

There we summarized two issues mentioned above when teachers try to manage the web collaborative learning.

- Discover the impact factors of learning situation:
  Since the social interdependence affects the collaborative learning deeply, teacher need some assisting tools to find out the impact factors hidden in web logs and group portfolios.
- Prevent groups to be failed by experience analysis:
  At the end of semester of a collaborative learning, the experience and logs could be an important reference for the next semester. If teacher could find out the impact reason of specific states, her/he could prompt the group to learn or prevent the group from failing.

To resolve the issues listed above, our research tried to employ some data mining techniques and supported some useful information for teachers to manage the web collaborative learning.

The participators in this research included 7 teachers, 5 teaching assistants and 706 students. All of these participators teaching and learning via video compacted disc (VCD), and collaborated the group works and discussed to members on web. Students were divided into 2 classes: Class-A and Class-B. Both classes were used the same teaching strategies and curriculums. In this research, the learning logs of Class-A were used for constructing the relational map between each learning feature. It was the simulated past-experience for predicting the learning states of Class-B. The result shows that with the assistance of these useful tools, teacher could track and guide the web collaborative learning with meaningful learning states, discover the impact factors associated with the social interdependence, and predict the learning state and make a teaching decision online.

2 The Bayesian Believe Network

This work employed the Bayesian belief network (BBN) [6] to model the learning situations and represented the causal relationship between these situations in a graphical map. The BBN is a directive map composed by some nodes and arcs, these nodes and arcs represent the joint probability distribution for a set of variables. In this research, the nodes represent the group's *Feature Space (FS)* [7], and the arcs represent the relationship and the joint probability of two FS. It is named as "FS-based Bayesian belief network (FSBBN)". In Figure 1, it is an example for illustrating the FSBBN of a web-based collaborative learning: the "Learning Failed" node represented the group grade less than 60 at the final of semester. The "Homework Late Submitting" node represented the group homework were submitted after the deadline. The "Less Discussing" node represented the discussion amount in discussion place were less than 3 post each day. The "Less Login" node represented the average login times of a group less than 1. The "Leader Failed" node represented the group leader were failed in his jobs. The arcs in BBN represented the causal relationships between each node, and were constructed by the Bayesian Classifier. The Bayesian Classifier figured out the probability of each node that was affected by the previous nodes.

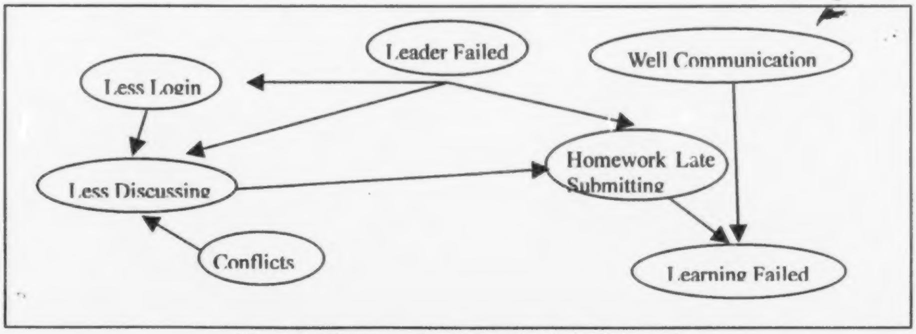


Figure 1: The example of Bayesian belief Network

Some probability tables deducted the directive arcs in FSBBN. Table 1 presents the probability of "Learning Failed" of a group, where "Learning Failed" is abbreviated to F, "Homework Late Submitting" is abbreviated to H, and "Well Communication" is abbreviated to W. The direct effects of "Learning Failed"included the probability of "Well Communication" and "Homework Late Submitting" both. Moreover, the direct effects of "Homework Late Submitting" included the probability of "Leader Failed" and "Less Discussion". In this way, the effects of "Learning Failed" included the probability of "Well Communication", "Homework Late Submitting", "Less Discussion", "Less Login", "Conflicts and Leader Failed".

	H,W	H,¬W	¬H,W	¬H, ¬W
F	0.35	0.93	0.02	0.54
¬F	0.65	0.07	0.98	0.56

Learning Failed

Table 1: The probability of Learning Failed

The FSBBN makes assistance for teachers finding out the relationships between each learning FS. It also supported the need for teaching decision in a web-based collaborative learning system, and will be illustrate in the following chapters.

3 Applying the Data Mining Tools in Learning Tracking and Teaching Guidance

To track students' learning status, teacher must to obtain the relationships between each impact factors of collaborative learning. In this chapter, several BBN tools support a directive map that illustrate these FS and help teachers to discover the objective causal relationships between these FS. These causal relationships support teachers to make a decision and promote the group to learn, prevent the group to be failed at the end of semester. This chapter will introduce some of free-wares and show how to apply these public tools in constructing a FSBBN and managing a web-based collaborative learning.

3.1 Observing the collaborative learning states and find out the impact factors

Bayesian Knowledge Discoverer (BKD) is noncommercial classification software for research, released by Knowledge Media Institute of Open University of UK. [8]. The aim of BKD is to provide a Knowledge Discovery tool able to extract reusable knowledge from databases, without expecting any particular methodological background from the user. To this aim, BKD uses BBN as a graphical representation of the dependent model in the database. Once the BBN generated from data, the network can be used as a self-contained reasoning system, able to provide observation, predictions and support decision making for a teacher.

The BKD needs a text file exported from database for constructing the BBN. The input data could be numeric or discrete data. To generated the complete causal network of a web collaborative learning, the input data of BKD should include the learning FS, personal profiles, online access statistics collaborative portfolios, and discussion situation. In Table 2, it illustrated that the teachers' interesting items about the learning situations. There are two groups of items: (1) learning FS (2) online statistic. All the values in this group were discrete Yes/NO or a label of level. The other items in second group were the online statistic from database, including the students' profiles, web accessing and discussion.
In Table 2, the "Conflict" means if the members have ever conflicted on the project goal with members, it represented the goal independence of a group. The "Lack Leadership" means the group leader failed in her/his role, it represented the leaders' role independence. The "Poor Comm" means the members made the communications with others rarely on the issues of project. The "Distrust" mean students have low trust with members about the discussion content and sharing resource, both of above FS represented the resource interdependence of a group. The "Poor Help" means if members did not like to help others in collaborative

project, it represented the reward independence of a group. The "Query Work" means the number that member query the current result of group project. It represents task interdependence of a group. Finally, the "Lower Grade" means the group failed in learning and got lower grades.

Group id	Conflict	Lack Leadership	Poor Comm	Distrust	Poor Help	Query Work	Disc Online	Email	Disc Lonely	Lower Grades	...
1	N	N	Y	N	N	64	6	6	48	Y	
2	Y	N	Y	N	N	165	4	21	14	N	
3	Y	Y	N	N	Y	0	0	13	19	Y	
4	N	N	N	N	N	44	3	19	13	N	
5	Y	N	Y	N	N	196	4	26	25	N	
6	Y	N	N	N	N	198	57	6	170	N	
7	Y	N	Y	Y	N	91	4	27	33	N	
8	Y	N	Y	N	N	175	3	6	41	N	
9	Y	Y	Y	N	N	68	1	8	16	N	
10	N	N	Y	N	N	70	7	13	23	Y	
...											
35	Y	N	Y	N	Y	12	2	3	15	Y	

Table 2: The input file for BKD (Class A)

After the input file import into the BKD, the system will construct a FSBBN for teachers to observe the relationships and the probability model for decision-making, like the example in Figure 1.

3.2 Experience reuse to prevent groups to be failed

To prevent groups to be failed early, the teacher would like to predict the group's learning state at the end of semester by the current states and her/his past teaching experience. The ideal to predict the learning states is to classify the new FS into the classes divided by the past FSBBN. In traditional classification tools, it contains two steps for prediction: first the system is trained by teacher's experience on a set of past data. The second, system will classify the cases by the trained set. The Robust Classifier (Roc) [8] is also noncommercial classification software for research, released by the Knowledge Media Institute of Open University of UK. It supports an efficient tool for teachers to classify the past FS into several classes, and predict the new FS into these classes.

There are four steps of Roc to predict a set of real-time FS illustrated as follows:

1. Define the Bayesian classifier from a database:
2. Class selection and discretization:
3. Learning the past learning FS:
4. Predictions the real-time FS:

There is an example how a teacher using the four steps to prevent the group learning failed:

Step1. Collecting the learning FS and online access data as the input file. Table 2 illustrated the teacher collected the input data of Class A for constructing the classifier. The input file has the same file format as the input file for BKD system.

Step2. Select one of the FS of input data as the class. For example, the teachers are interesting to obtain which group with the real-time FS will get lower grade at the end of semester.

Step3. After the Roc learning procedure proceed in this step, it generated the probability of each FS to the selected classes (Lower_Grades). In Table 3, two of FS: "Conflict" and "Leader_Failed" was listed and illustrate the probability of the group to be failed and get lower grades (Lower_Grades)

Step4. Predict the probability of learning failed via the online data of Class-B. Although Class A and Class B were hold at the same semester, for prove the ability of prediction in this paper, the online FS of Class B were used as the test data. In case of the prediction were hold before the end of semester, some data were absent until the end of semester when predicting. In this research, several FS of Class-B were marked as '?' for simulating this situation.

```
Class Lower_Grade
N Y                  Attribute Conflict                    Attribute Leader_Failed
(0.690 ) (0.310 )                      Y         N                              Y         N
                     N           (0.621 )  (0.379 )      N              (0.172 )  (0.828 )
                     Y           (0.385 )  (0.615 )      Y              (0.231 )  (0.769 )
```

Table 3: The results of Roc learning procedure

In Table 4, the coverage shows all the cases of Class B are predictable in RoC. The column "Lower Grades" is the original FS of Class B. It must be noted that in a real life case, this value of "Lower Grades" of Class B will not be known until the end of semester. The column "Predicted Result" is predicted by RoC with the input data in and the learning data. It is clearly that the system predicted group 1 would not get a Lower Grades at the end of semester. And the fact matched this prediction. However, the prediction of group 2 mismatched the fact. The column "Probability" represents the probability of such predictions of each group. In this experiment, the predicted result showed that the accuracy is 77.77% (28 correct, 8 incorrect). This credible result of RoC provides teachers not only predict the probability of each group to be Lower Grades, but also all other FS groups of social independence and will be discussed in next chapter.

Group id	Predicted Result	Lower Grades	Probability
1	N	N	0.561
2	N	Y	0.977
...	...	...	...
36	Y	Y	0.897
Correct:	28		
Incorrect:	8		
Accuracy:	77.77 %		
Coverage	100.0 %		

Table 4: The output file of predicted result (Class B)

4 Experience and Result

In this chapter, teachers exhibit a web-based collaborative learning on the "Introduction of Computer Network and Applications" course. The data mining tools such as BKD and Roc were employed and help teachers to observe the learning states, intervene the learning to promote collaborating and illustrated the ability to prevent the group to be fail before the end of semester.

4.1 The participants and the grouping on web

The participators included 7 teachers, 5 teaching assistants and 706 students in Taiwan. The 63% of students are teachers in high school, and all graduated form colleges or above. The 706 students were divided randomly into tow class named Class-A and Class-B. After the first month for students to be used to the environment, functions and operations, students were grouped into several heterogeneous groups by the grouping tools [9]. The grouping criterion included the personal profile and thinking style [10]. There were 35 groups in Class-A and 36 groups in Class-B, average 9.9 students in a group. The 63.5% of students are also the teachers in high school and all graduated from college or above. It represents most of the students did not have the difficult to get on-line. The students read the curriculums from video compacted disc (VCD). After the reading work, students must register in the NCUVC [11][12][15] collaborative learning system. The NCUVC support a web discussing space, collaborative project space and sharing resource in space, etc. The first group task is to elect the cadres, included the leader, co-leader and the clerk, and check-in the group private working space. The group private working space supported the online and offline discussion room, a resource sharing space, a portfolio space, a project scheduler, and a window for querying the member working states.

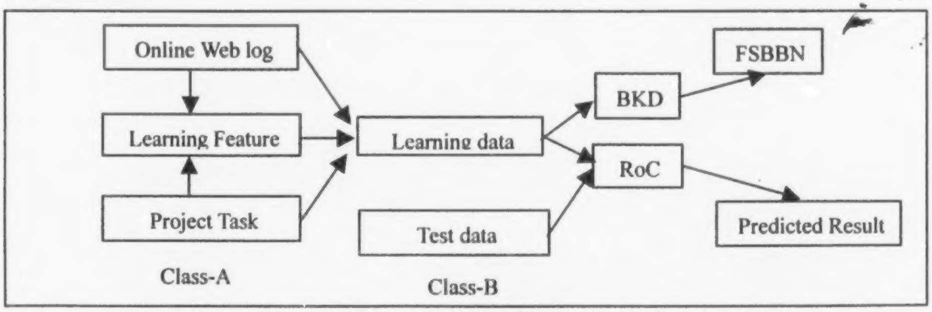


Figure 2: The process for observing and predicting the learning situation

Figure 2 illustrates the process for teachers to observe the learning FSBBN and predict the learning situation. For observing the learning states, teachers collected all the online/offline data to be the learning data and the input data for BKD system. The output of BKD is the form of graphical FSBBN. For predicting the learning situation of Class-B, teacher employed the training data to be the first input data of RoC system. The online data of Class-B is the test data and second input data of RoC. The result classified the cases of Class-B into the classes of Class-A, and support probability of each class for teachers.

4.2 Observe the learning states

After all the groups were ready to work together, teachers assigned the first project to each group. It is a collaborative project for constructing the web site for teaching the techniques of web programming. In the progress of project, teacher would like to observe the learning and working states of each group. There two type of observing method supported NCUVC. First, the subjective FS: teachers could construct the FS subjectively and focus on the specific group learning/working states, which are interesting for individual teacher. Because different teachers will define different FS for each group, it is the subjective observing tool dependent on teachers. Second, the objective FSBBN: it is a causal map based on the FS and all the accessing logs on web, the BKD system will construct the FSBBN for each group. Therefore, teachers could track the learning states and the causal relationships between each FS and access log. Because the causal map was constructed by the Bayesian method, it support the objective observing tool. The following figure is an example for observing the learning Class-A.

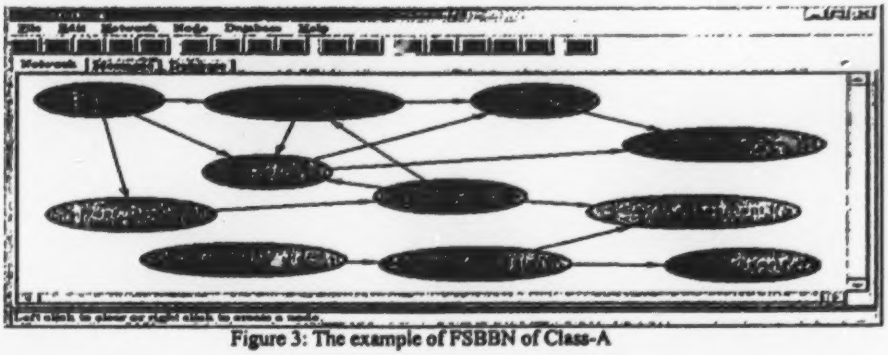


Figure 3: The example of FSBBN of Class-A

In Figure 3, teachers were interesting the causal relationships of homework grades (Hw_Grade) of each group. This FSBBN illustrated that the homework grades were influenced by the complete rate of homework (Complete_Rate). The BKD also figured out the probability of each level of Complete_Rate (high,mid,low) and the level of Hw_Grade(good,general,poor). It was illustrated in the following table.

Grade Complete_Rate	Good	General	Poor
High	0.956	0.022	0.022
Mid	0.006	0.990	0.004
Low	0.028	0.042	0.930

Table 5: The probability of Complete_Rate and Hw_Grade

It is clearly that the group with higher complete rate, it has higher probability (0.956) to get good grade at the end of semester. In contract, the lower complete rate has higher probability (0.930) to get poor grade. Thus, teachers could observe the causal relationships of each learning features with the help of FSBBN.

4.3 Discover the causal relationships between FS and social interdependence

The social interdependence exists when the outcomes of individual are affected by each other's action [1] [13]. It plays an important role for the success of a collaborative learning. However, teachers have difficult for observing the social interdependence without face-to-face interaction on web. In this chapter, all the social interdependence was transformed into the form of FS and the FSBBN, these representation could be a window for observing and predicting the level of social interdependence. With the categories made by Johnson's *Interdependence Typology* [1] the five type of *positive interdependence* must be discussed first. The next table illustrated the web collaborative learning FS related to John's positive interdependence. Johnson's positive interdependence was not evident These FS were classify by teachers' subjectivity

Positive Interdependence	Feature Space
Goal interdependence	Goal_discuss, Query_group_portfolio, Query_members_work, …
Reward interdependence	Grades, Help_members ,Answer_discussion,…
Resource interdependence	Discussing, Upload_resource, Query_resource, …
Role interdependence	Allot_task, Leader_failed, Individual_responsibility, …
Task interdependence	Portfolio, Query_scheduler, …

Table 6: The associated feature space for observing the positive interdependence

However, some FS associated with these positive interdependence was hidden and not listed in the teachers' subjective FS. The Bayesian method could discover these *missing data* [14] and the causal relationships. In this experiment, teachers tried to collect all the web logs and the result of questionnaires, transformed these data into 70 FS as the input file of BKD. The BKD could discover the missing related FS associated with this social interdependence. First, teachers classified the groups into two classes: goal interdependence and poor goal interdependence. The new class was added into the system as the new FS and named as "Goal_Interdependence". Teachers could selected all the FS or a set of FS including the new FS as the input data of BKD. After the analysis of BKD, the new related FS associated with "Goal_Interdependence" could be discovered in the FSBBN.

4.4 Prevent the group to be failed

In chapter 4, the Roc system supported the credible prediction for the FS of Class B with the experience of Class A. In this experiment, the correct rate is 77.77% is good enough for a teacher to prevent the group to be failed. In fact, some irrelative learning data will reduced the correct rate. For saving time and increase the correct rate of prediction, teachers would like to migrate the redundant FS and remain the necessary FS. The issue is which FS should be migrated and which FS should be remained? The positive interdependence supported a good idea about this issue. In Table 7, teachers tried to predict the probability of learning failed (Low_Grades) with different FS associated with the positive interdependence.

Learning data	Correct Rate of Prediction
Goal interdependence FS	100%
Reward interdependence FS	88.89%
Resource interdependence FS	88.89%
Role interdependence FS	66.66%
Task interdependence FS	86.11%
All the FS	77.77%

Table 7: The correct rate of prediction with different type of FS learning data

The result illustrated that teachers selected different part of FS related with the social interdependence and improve the correctness of prediction. It is interesting that in this experiment, the FS related with goal interdependence has the most dependent relationship with the group grades. The FS related with role interdependence has the least dependent relationship with the group grades. Therefore, teachers could observe the goal interdependence FS at next semester to prevent the group from being failed. Teachers could not only predict the fail probability of a group, but also predict any FS with the subset of all the FS in this system.

5 Conclusion

To assist a teacher in tracking and guiding a web collaborative learning this work has presented the assisting tools for observing the group states, discovering the impact factors of learning situation, and reuse the experience to predict the learning state. The Bayesian method supports an efficient way to achieve these purposes. Without the proposed mechanisms, a teacher must spend considerable time in trying to analyze situation from huge amount of unorganized web logs. The causal relationships of learning situations were hard to track. To predict the learning situation depended on teacher's individual experience that is imprecise and could not be reused for other teachers. This work (1) transformed the huge amount of meaningless web log into the form of readable and meaningful feature space, (2) supported the graphical FSBBN for observing the learning states and discovering the hidden impact factors of web collaborative learning, (3) predicted the learning situation successfully before the end of semester with the online learning situation and experience of past semester.

Observation and tracking the group's learning situation help teachers determine instructional strategies and group's learning performance. With the advantage of feature space and FSBBN, teachers can observe learning performance and analyze the influence of learning situations. The learning space is constructed as a hierarchical graph and teachers can define features for themselves via the instructional domain knowledge, doing to easily and meaningfully. The FSBBN illustrated the causal map of learning situations. With the past experience of tracking and guiding, teachers could predict the learning situation before the end of semester. Therefore, teachers could intervene the group learning to prevent the group from being failed.

Finally, the experiment result demonstrates that teachers' tracking and guiding a web collaborative learning with 706 students were successful and efficient.

Acknowledgement

The authors would like to thank the National Science Council of the Republic of China for financially supporting this research under Contract No. NSC88-2520-S-008-002.

Reference

[1] Johnson, D.W., and Johnson, R.T. "Learning together and alone" (33rd ed.). Egnlewood Cliffs, NJ: Prentice Hall

[2] Collis, B., Andernach, T., & Van Diepen, N. "Web Environments for Group-Based Project Work in Higher Education". International Journal of Educational Telecommunications. No.3 Vol.2 pp.109-130.

[3] Shotsberger, P.G., Smith, K.B., & Spell,C.G. "Collaborative Distance Education on the World Wide Web: What Would That Look Like?", Proceeding of CSCL, 1995. pp.312-316

[4] Zaïane O., Xin M., and Han J. "Discovering Web Access Patterns and Trends by Applying OLAP and Data Mining Technology on Web Logs". ADL 1998: 19-29

[5] Adams, D.M. and Hamm, M.E. "Cooperative Learning, Critical Thinking and Collaboration Across the Curriculum". Charles C Thomas Publisher, 1990

[6] Gertner, A.S., Conati, C., VanLehn. K. (1998). Procedural Help in Andes: Generating, Hints Using a Bayesian Network Student Model. AAAI/IAAI 1998: 106-111

[7] Ou, K.L. Chen, G.D., Liu, C.C., and Liu, B.J "Instructional Instruments for Web Group Learning Systems : The Grouping, Intervention, and Strategy" Proc. The 5th Annual Conference on Innovation and Technology in Computer Science Education, 2000

[8] Ramoni, M. and Sebastiani, P. "An introduction to the Robust Bayesian Classifier". KMI Technical Report Kmi-TR-79, Knowledge Mddia Institute, The Open University, Milton Keynes, 1999

[9] Chen, G.W., Ou, K.L., and Liu, C.C. "Instructional Instruments for Grouping, Intervention, and Strategy Analysis on Web Group Learning Systems". Proc. International Conference on Compters in Education 99, Chi-ba, Japan. (October, 1999)

[10] Sternberg, R. "Thinking Styles" ,Cambridge University Press.

Gertner, A.S., Conati, C., VanLehn. K. (1998). Procedural Help in Andes: Generating, Hints Using a Bayesian Network Student Model. AAAI/IAAI 1998: 106-111

[11] Ou, K.L., Chen G.W., and Liu,B.J. "A Group Learning Environment in a Virtual Classroom Built on WWW". Proc. 6th International Conference on Computer Assisted Instrution, 1997

[12] Liu, C.C., Chen, G.W., Ou, K.L., Liu, B.J., and Horng, J.T. "Managing Activity Dynamics of Web Based Collaborative Applications". International Journal of Artificial Intelligence Tools, Vol. 8, No. 2

[13] Webb, N.M. "Peer interaction and learning in small groups". International Journal of Educational Research, 13(1), pp. 21-29.

[14] Little, R.J.A. and Rubin, D.B. "Statistical Analysis with Missing Data". Wiley, New York.

[15]Ou, K.L., Chang, C.K., & Chen, G.D."Web-based Asynchronous Discussion System". Internatinoal Conference on Computers in Education 1998.

[16] Chang, C.K., Chen, G.D., Ou, K.L., & Liu, B.J. "Student Portfolio Analysis for Decision Support of Web-Based Classroom Teacher by Data Cube Technology". ED-MEDIA/ED-TELECOM 98

TWO TYPES OF VIRTUAL SCHOOL IN INET SUPPORTED BY TEACHER'S GROUP—COLLABORATION TYPE AND LOOSELY CONNECTED TYPE

Shoichi Kinosita* and Nobuyuki Arakawa**
*SEITOKU University, *550, Iwase, Matsudo, Chiba, Japan 271-8555,*
E-mail: kino@po.jah.ne.jp
**Kamishinmei Elementary School, *Futaba-4, Shinagawa-ku, Tokyo, Japan*
Email: arakawa.nobuyuki@nifty.ne.jp

1 Introduction

We construct a virtual school in INET since December 1997 about elementary and secondary education. This virtual school is collaboration type. About 10 teachers are the managers who control the open and close to the courses. This members also join to "Project Group for Learning Process" founded at 1984 in Matsushita Audio-Visual Research Foundation. The courses are consists of Japanese Language, Mathematics, Social Science, Natural Science, Arts, etc. The writer of each course is voluntary and often invited by the manager. The system of this school is controlled by CGI program that counts and classify the visitors.

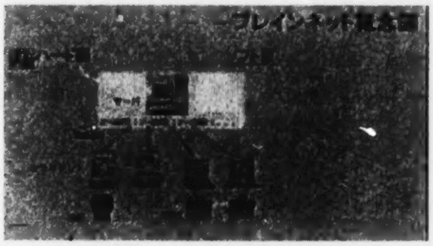


fig. 1 Structure of Type [A]

The other type -Loosely connected- virtual school will be appeared in several months. This type is the mirror image of writer's daily lesson. The writer is also the teacher at a classroom and the course is the same contents as the lesson at the class. The first purpose of this type is the help for absent student at lesson with inevitable reason.

The second purpose is the teacher's skill up the teaching methods and fill up his contents. Each course is gazed by the other writer and visitor by critical viewpoints and comments may send to him by E-mail or another way. These comments will effective for the writers. The writers are loosely connected by browsing and criticize for each other.

2 Comparison of Two Types of Virtual School

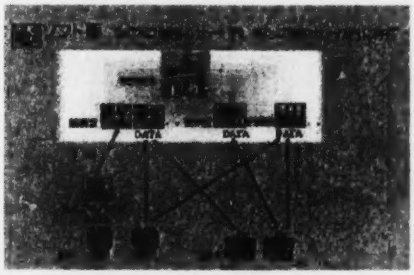


fig. 2 Software Structure of Type [A]

Let's call collaboration one is the type [A] and a loosely connected one is the type [B]. Type [A] may have fine course by fine teacher by the reason of solid watch and control and severe criticism. But the number of writers may be limited because of difficulties to make fine or excellent course. In fact, the number of writers of our school is about 20 teachers today. The increase of number of writers is very slow.

Type [B] may readily have many teachers because the reporting of own daily lesson wants little efforts except for some reviews and writing time.
On the other hand, the quality of course may not be

expected, and the learners to be supposed are very restricted.

Results

The two types [A] & [B] will be exist parallel to each other and exchange the writer, or perhaps invite the writer for type [B] at first and next to type [A] if the course will fine and universal.

The Language of both types is Japanese and every learner or visitor needs to read Japanese Language. This is an issue that is easily overcome by some Japanese to English interpretation software. Our two schools slightly gather the writers who want to spread their unique lesson and the effect appeared in the mutual discussion about order in lesson, resources, tools, and illustrations in both type.

There are many virtual schools in Japan and all over the world. These are almost supported by ministry of education, nation, or company who have many staffs working with development and editing. Our tiny two virtual schools will combine the teacher's skill and fine lessons from voluntary teachers in Japan or other country and serve the chances to learn for many learners who can't go to the school with willingness to learn.

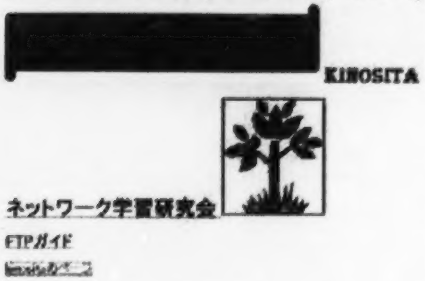


fig. 3 Front Page of Type [B]

References

[1] Our type [A] Home Page, http://www.mef.or.jp/bnm/(accessed on July 20,2000)
[2] Our type [B] Home Page, http://www.kinosita.itabashi.tokyo.jp/(accessed on July 20,2000)

Virtual Inhabited 3D worlds and Internet Based Learning Environments

Jens F. Jensen
InterMedia Aalborg, Aalborg University
Niels Jernersvej, NOVI4-215, DK-9220 Aalborg East, DENMARK
Phone: +45 98 15 62 79 Fax: +45 98 14 24 44
E-mail: jensf@hum.auc.dk

This paper addresses some of the central questions currently related to 3-dimensional Inhabited Virtual worlds (3D-IVWs) and their virtual interactions and communication in Internet Based Learning Environments. First, 3D-IVWs-seen as a new and unique form of multimedia-are introduced and the social construction of the 3D-IVW technology is briefly discussed. Second, a selection of the basic concepts and identifiable entities in 3D-IVW s is denned and commented upon. Third, modes of interactivity and (virtual) interactions between users, avatar, bots, etc. in the new Virtual Worlds are briefly presented and typologized. Finally, two Internet based virtual inhabited 3D learning environments -one US-based and one based in Denmark- will be described and analysed.

*The paper was not available by the date of printing.

WALTZ: A Web-based Adaptive/Interactive Learning and Teaching Zone

Long-Chyr Chang, Heien-Kun Chiang, and Pi-Shin Wey
Da-Yeh University
112, Shan-Jiau Rd., Da-Tsuen, Changhua 51505
Tel: +886-4-8528469~3138
E-mail: long@aries.dyu.edu.tw

Web-based 3D life-like learning environment is becoming a major research topic. WALTZ supports dynamic, collaborative, and synchronous/asynchronous learning activity in 2D/3D virtual environments. In this paper, an overview of WALTZ's architecture and design philosophy is presented. Then, a WALTZ-style Pythagorean theorem learning space is shown to illustrate the powerfulness of the WALTZ environment. The ultimate goal of WALTZ is to provide an active and pleasant social learning environment for learners to study collaboratively and waltz happily in shared virtual, dynamic and yet exciting learning spaces.

Keywords: **Web learning, Virtual Reality, Collaborative Learning, CAI**

1 Introduction

The World Wide Web (WWW) opens a new learning space that learners can communicate and share their idea in this wonderful virtual world. The new learning space provides versatile ways of communication and interaction that would make learning more fun and entertaining than ever before. It has captured great attentions from CAI (Computer Assisted Instruction) researchers since its debut as it has great potential to surmount the difficulties and weakness of traditional CAI systems [5,7,8]. Up to date, most web-based CAI systems only support asynchronous learning and still use 2D hypermedia style to showcase their learning materials and instructions [13]. Some systems [3] might support collaborative learning additionally, however, they are still far away from success as the new way of learning also brings new problems that are even more challenging for educators. There is no simple way of knowing what the best web-based learning environment would be and how to utilize this environment effectively for teaching as well as learning. It is a research area that needs to be seriously explored through the cooperation of experts from different disciplines such as subject content experts, instruction developers, CAI researchers, and web engineers etc. Despite such problems, most educators would agree that discovering leaning, collaborative learning, learning by doing, and learning with fun are among those of effective learning methods according to Constructivism [2,9,12]. Fortunately, recent rapid progress of web technologies such as JAVA, VRML, and network technologies bring a new opportunity for implementing the learning methods described above. Before VRML was created in 1994, web spaces are flat. Most web systems are hypermedia style, which do not have enough expressive power of modeling real world entities. The living world specification [11,14] in 1997 illustrates emerging needs of dynamic and interactive 3D shared virtual worlds. Today there are many popular 3D avatar (virtual human) based virtual society (mainly for social meeting and chatting) websites [1]. The trend of web windowing systems is moving from 2D multimedia representation to 3D shared virtual space. WALTZ foresees the integration of the two media will become a popular form of presenting learning materials as well as a virtual fun place to play, learn and exchange idea. Many studies have also indicated that a successful web-based learning system not only has to be content-rich but also highly interactive as well as highly adaptive to meet the needs of learners [5,8]. Transforming 2D virtual classrooms into life-like 3D learning space is certainly one of the research directions that deserve special attention.

WALTZ, a research project under active development, is a web-based adaptive/interactive learning and teaching zone, which supports dynamic, collaborative, and synchronous/asynchronous learning in 2D/3D virtual environment. WALTZ envisions that the CIA (Content, Interaction and Adaptivity) learning model will be an essential ingredient of future successful web-based CAI (Computer-Aided Instruction) systems. The CIA learning model is developed based on the Interaction Model of Gilbert [5] and Instruction Design Model of Moallem [15]. The CIA learning model has three corner stones: Content, Interaction and Adaptivity. The overlay areas of each neighboring corner stones are versatile representation, adaptive instruction and adaptive interaction. Figure 1 illustrates the CIA model in detail.

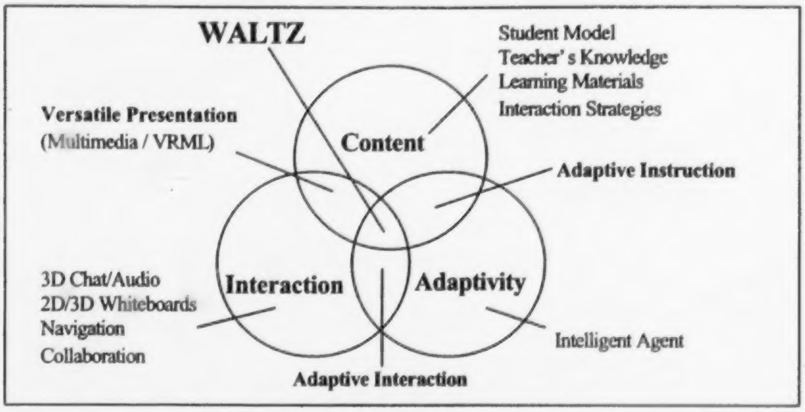


Figure 1. WALTZ's CIA Learning Model

2 An Overview of WALTZ

The main goal of WALTZ is to develop a web-based interactive and adaptive environment based on the CIA learning model so that it can be easily adapted to any instructional and learning subjects according to the theory of constructivism. WALTZ is capable of supporting discovering learning, project-based learning and collaborative learning in 2D/3D shared virtual learning space. WALTZ supports the following features:

(1) Dynamic interaction and flexible communication

WALTZ supports two types of interaction: Human-Computer Interaction and Social Interaction. The former supports instructional interaction and emphasizes individual and adaptive learning. Learners can browse information, navigate virtual worlds, and respond to problems that are dynamically generated from the WALTZ's system according to student's learning status. The latter supports collaborative mechanism and emphasizes collaborative learning among students, student and teacher, groups of students, and the whole class. In addition to support asynchronous communication in traditional 2D virtual classroom setting, WALTZ also supports synchronous communication in both 2D shared and 3D shared learning space as well.

(2) Versatile presentation of multimedia and virtual reality

Both multimedia and virtual reality have their advantages and disadvantages. Multimedia learning has great success in instruction and learning in recent years. Virtual reality is the best technology to provide 3D-life environment. Web-based multi-user environment are even envisioned as one of the popular user interface in the future [9]. However, it is still hard to construct a high quality VR system in terms of cost and technology. Furthermore, virtual reality might not be suitable for all types of instruction. Thus, the use of both multimedia and virtual reality technologies in alearning system will be able to support a rich and effective learning environment that attracts students.

(3) Agent-based learning environment

Based on Constructivism, an ideal learning system should provide adaptive learning scenarios, where teaching materials and learning activity would be individualized according to students' mental model and learning needs. WALTZ supports helper-agents, which would interact with learners in several ways. For example, an instruction agent would present an easier course material to a learner if it found the current content is too difficult for him/her. An interaction agent would suggest a group of learners to use a 3D whiteboard instead of a 2D whiteboard if they were trying to understand the three dimensional structure of molecules. WALTZ's virtual classroom could be populated with shared objects and active agents, such as user agents (represented by virtual human) and helper-agents so that users can enjoy and learn effectively in the social learning environment.

(4) Collaborative mechanism for activity management

Recently, group learning has been found to have a positive effect during learners' learning process [6,17]. In order to effectively support WALTZ's virtual, shared, and interactive social world, a set of collaborative mechanisms has been developed to manage interactions among students, teachers, and instructional content. These mechanisms [4] include object association, automatic object notification and change management, object delegation, object negotiation, object constraint, and object history tracking. Built on top of these collaborative mechanisms; WALTZ constructs an agent-based group activity model, where each participant is modeled as a user agent to manages the dynamic behaviors of all participants in an activity.

(5) Standard VRML authoring language for shared multimedia contents

Content development plays an important role of a successful web-based learning system. WALTZ supports authoring tools for shard virtual worlds based on multi-user VRML living world specification. This feature will make developments of shared 3D contents almost as easy as non-shared static 3D contents. Message passing between shared objects on different computers will be through new prototyped VRML nodes and WALTZ communication subsystem will update the states of each shared object once they are changed.

(6) Open architecture and platform independent web-based learning environment

The enchantment of web-based learning environment in WALTZ is due to its global network connectivity, simplicity and yet friendly user interface, and extensible architecture. The implementation of WALTZ is based on JAVA, VRML and standard network technologies so that it can be easily applied to other systems or platforms. A client can use current popular web browsers, such as Microsoft Internet Explorer or Netscape Navigator (with VRML plug-ins, such as Cosmo player or Cortna player) to browse information, navigate, and communicate with other clients in the WALTZ.

WALTZ is expected to be able to

- represent different media information effectively,
- construct various learning scenarios by integrating the technologies of virtual reality, multimedia, and World Wide Web, and
- to provide activity management facilities and collaborative mechanisms to enable highly interactive collaboration among all students, teachers, and instructional material in collaborative learning activity.

3 The Architecture of WALTZ

WALTZ is basically a client/server distributed virtual reality system. The client side provides human-machine interface that uses the technologies of audio, image, HTML, VRML, and the Java Internet capabilities to provide a web-based multimedia/virtual classroom according to the theory of Constructivism. Its environment contains JAVA control applet, multimedia, virtual world interface and collaborative tools such as text chat tool and shared whiteboard. Figure 2 illustrates the architecture in detail. Each client (user) can join one to multiple sessions to collaborate with other participants in 2D/3D shared virtual classrooms (or learning spaces). The server side is composed of five main components: (1) collaborative mechanisms subsystem, (2) VRML world server, (3) intelligent agent-based server, (4) Web server, and (5) communication subsystem for supporting real-time synchronous or asynchronous message interchange. The collaborative mechanisms subsystem ensures that the inter-dependency/intra-dependency of all activities/participants will be maintained and validated during their interaction. In addition, notification, delegation or negotiation protocols will be executed once some events of interest are triggered. The VRML world server will handle all VRML events coming from the event manager and updates the states of each shared VRML objects. The agent-based helpers communicate with the activity manager in inferencing and discovering potentially new learning patterns of students based on the diagnosis and feedback of students' learning history. A communication subsystem supporting TCP/UDP/RTP protocols is used by all components of WALTZ to facilitate the real-time synchronous or asynchronous communication of interacting objects (or entities). The web server is responsible for downloading multimedia and VRML representation of instructional materials or virtual learning space.

4 Pythagorean Theorem Learning Space

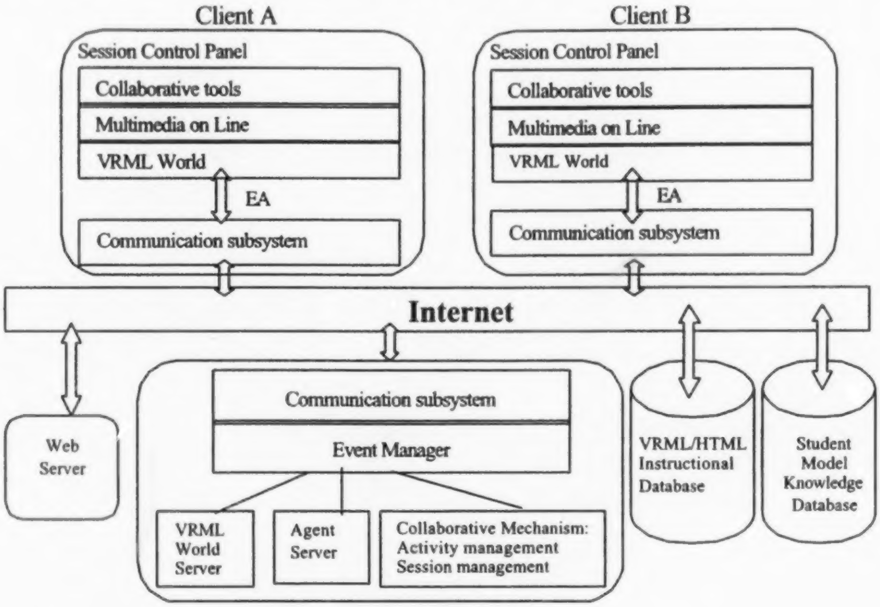

Client A
Client B
Session Control Panel
Collaborative tools
Multimedia on Line
VRML World
EA
Communication subsystem
Session Control Panel
Collaborative tools
Multimedia on Line
VRML World
EA
Communication subsystem
Internet
Web Server
Communication subsystem
Event Manager
VRML World Server
Agent Server
Collaborative Mechanism: Activity management Session management
VRML/HTML Instructional Database
Student Model Knowledge Database

Figure 2. The Architecture of WALTZ

Pythagorean theorem is an interesting mathematical subject of the eighth grade students in Taiwan. It has rich heritage in mathematical history. Based on our survey, most current web-based systems teaching Pythagorean theorem only focus on the 2D interactive theorem proving process. WALTZ, in contrast, not only offers 2D interactive theorem proving process but also provides several key learning components to help students better understand the fundamentals of Pythagorean theorem. Figure 3 is an entry to the Pythagorean theorem learning space, where users can meet and navigate the virtual world dynamically or enter into any one of the learning components described below. The user interface contains two parts: VRML virtual world and JAVA applet control panel. The VRML virtual world is the learning space, provided by the WALTZ web server, where learners can navigate the virtual world, enter into a learning session, and meet other learners in the same session. The control applet provides chat tools so that a learner can talk to other learners for collaborative work.

The design of WALTZ-style Pythagorean Theorem learning space intends to support the features that are listed in Section 2. Current implementation of the WALTZ-style Pythagorean Theorem learning space consists of the following five learning components:

(1) Multimedia instructions

In WALTZ, instructional design of Pythagorean theorem covered three on-line learning sections: history of Pythagorean theorem, prerequisite knowledge and skills of Pythagorean theorem, and all the concepts about Pythagorean theorem. Since Pythagorean theorem is related to the mathematical concepts in both algebra and geometry and each concept need different multimedia features for presentation. Thus, different multimedia components such as text, graphic, animation, sound etc. were carefully designed and arranged in the interface to present the subject domain.

(2) Collaborative and interactive Pythagorean theorem proof/verification

One of the major features of WALTZ is the collaborative learning environment for Pythagorean theorem proof/verification. The activity manager in WALTZ provides facilities for instructors/learners to create/modify/delete/join an activity/session, to assign permission, to set constraints, to record the history of learners' Pythagorean practices, and to support group awareness during their collaborative learning. Figure 4 is an interactive program that allows users to learn Pythagorean theorem by experimental method. Students can drag each vertex of the triangle. If it is a right triangle then one can visually verify if it satisfies the Pythagorean equation: a^2+b^2=c^2. If it is an acute (or obtuse) triangle then the Pythagorean equation is not valid and a^2+b^2 >(<) c^2. Figure 5(a) shows a collaborative Pythagorean theorem proving program in action which not only support collaboration but also group awareness (i.e. can visually see who is making the move). All participants in a collaborative application is managed under the control of activity (or session) manager, as shown in figure 5(b).

Figure 3. Pythagorean theory learning space

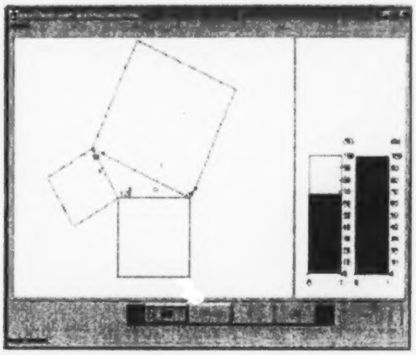


Figure 4. An obtuse triangle: a^2+b^2< c^2

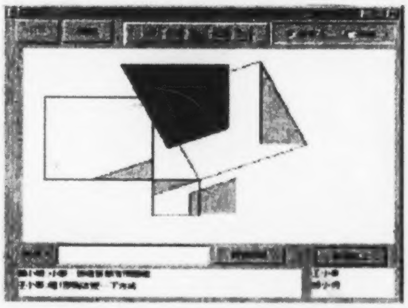


Figure 5(a). Collaborative Pythagorean application

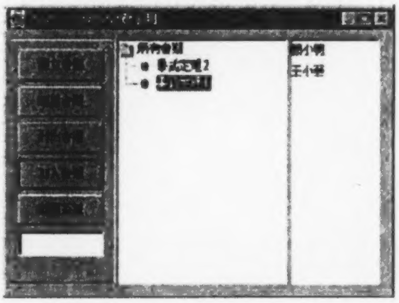


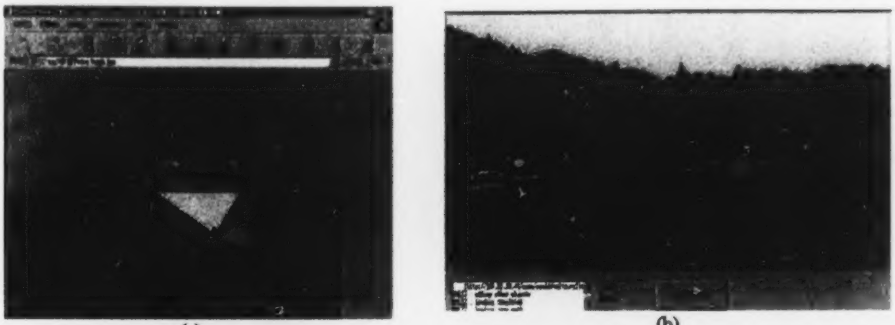
Figure 5(b). Session management

(3) Adaptive multimedia on-line testing

Traditional drill and practice CAI was criticized too boring to be used for young students. A web-based on line test without multimedia will have the same problem. A precompiled multimedia CAI program using Shockwave or Flash authoring technologies provides a better solution, however, it is not easy to change or add new contents adaptively into the program without recompiling the whole program. WALTZ is a dynamic virtual environment which can add/delete objects during users' learning journey. WALTZ intends to support an adaptive multimedia testing mechanism. Students will be given multimedia style test questions based on their current learning status. The multimedia test problems are generated on the fly by converting text-based questions stored in the database into multimedia representation. WALTZ will classify questions and suggest appropriate multimedia templates to make the conversion almost as easy as a PowerPoint presentation.

(4) Multi-user Project-based Pythagorean theorem virtual environment

To support project-based collaborative learning, a virtual environment is constructed. Team members can join the same session to solve the mathematical puzzles generated from the WALTZ system by interactively moving pieces of puzzle into the right place according to Pythagorean theory. Since WALTZ is a shared virtual environment that supports collaborative learning, each member of the team can see actions from other team members and they can communicate with each other to discuss how to solve the puzzle before they can go on to their next journey. Figure 6(a) & (b) illustrates a situation that a team must solve the puzzle of bridge using Pythagorean theorem before they can pass through the river and enter into the forest to continue their next journey.



(a) (b)

Figure 6 (a) & (b). Project-based multi-user collaborative learning space

(5) Pythagorean resource

Besides the aforementioned components, WATLZ also provide useful utility tools, such as online notepad and calculator that users can use conveniently. In addition, many different web sites relate to Pythagorean theorem were linked in WALTZ for learners to acquire various information easily.

5 Conclusion and Future Research

Due to progressively advanced development of 3D graphics and open network technologies, a web-based learning system that provides asynchronous and hyperlink-style environment might not attract young students in the feature. In addition, such systems will have great difficulty in constructing a situated, dynamic, and collaborative learning environment according to Constructivism. Therefore, This research proposed a CAI learning model from which a new architect of a web-based 3D life-like learning space, WALTZ, is created. By using Pythagorean theory as a case study, the study has demonstrated that WALTZ has a great potential to provide an improved learning environment over traditional virtual classroom setting.

Though WALTZ is still far from perfect, this research indicates that it deserves special attention among CAI research community. Next generation of WALTZ will focus on dynamic behaviors of agents via current state of the art MPEG-4 technology.

Acknowledgement

This research is founded by National Science Council (grant#: NSC 88-2520-S-212-004) in Taiwan.

References

[1] Blaxxun Interactive, http://www.blaxxum.com/ (accessed on June 2, 1998).

[2] Brooks, M. & Brooks, J., "In Search of Understanding: The Case for Constructivist Classrooms", Alexandra, VA:ASCD, (1995).

[3] Carlson, S. & Hawkins, R., "Linking Students Around the World: The World Bank's New Educational

Technology Program", Educational Technology (September-October), pp. 57-60, (1998).

[4] Chiang, H. K. & Lin, C. H., "A Study of Collaborative Mechanisms for Web Teaching and Learning", Journal of Da-Yeh University, Vol 8, No 2, pp. 63-79, (1999).

[5] Gilbert, L. & Moore, D. R., "Building Interactivity into Web Courses: Tools for Social and Instructional Interaction", Educational Technology (May-June), pp. 29-35, (1998).

[6] Harasim, L., "A Framework for Online Learning: The Virtual-U", Computer, pp. 44-49, (1999).

[7] Henin, I. & Droctor, L., "Incorporating the Web as Teaching Tool: Introduction", http://web.uvic.ca/~esg9/emo/emomain.html/ (accessed on May 1, 1999).

[8] Hughes, C. & Hewson, L., "Online Interactions: Developing a Neglected Aspect of the Virtual Classroom", Educational Technology (July-August), pp.14-55, (1998).

[9] Jung, B. & Milde, J., "An Open Virtual Environment for Autonomous Agents using VRML and Java", VRML 99 Proceeding, (1999).

[10] Kearsley, G. & Shneiderman, B. "Engagement Theory: A Framework for Technology -Based Teaching and Learning", Educational Technology (September-October), pp. 20-23, (1998).

[11] LW, "Living Worlds Specification, Draft 2", http://www.livingworlds.com/draft_2/index.htm (accessed on April 12, 1998).

[12] Merrill, M. D., "Constructivism and Instructional Design", Educational Technology, Vol 31, No 5, pp. 45-33, (1991).

[13] Merrill, P. F., Hammons, etc., "Computers in Education", NY: Simon & Schuster Company, (1996).

[14] Mitra, K., "Living Worlds", http://www.livingworlds.com/draft_1/lw_ideas.html (accessed on November 21, 1997).

[15] Moallem, M., "Instructional Design Model and Teacher Thinking: Toward a New Conceptual Model for Research and Development", Educational Technology (March-April), pp. 5-18, (1998).

[16] Pesce, M., "VRML: Browsing and Building Cyberspace", New Riders, (1995).

[17] Sherry, L. & Myers, K. M., "The Dynamics of Collaborative Design", IEEE Transactions on Professional Communication, Vol 41, No 2, pp. 123-139, (1998).

Web Based Real plus Virtual Observatory Project

Masato SOGA, Takuma OKUNO, Hideaki KAWANISHI
Faculty of Systems Engineering, Wakayama University
930, Sakaedani, Wakayama, 640-8510, Japan
Tel: +81-73-457-8457
Fax: +81-73-457-8112
E-mail: soga@sys.wakayama-u.ac.jp

We have been developing remote telescope system, which can be used by remote site via Internet with web user interface. Student in remote site can control the telescope easily and can see live picture of celestial bodies. If there is time difference between student's site and telescope's site, the student can see live picture of celestial bodies in daytime in classroom. It will be strong tool to learn astronomy. Moreover we are also developing virtual observatory which shows the status of the real telescope in a virtual space. The virtual observatory supports virtual planetarium, so that student in remote site can know what can be seen in the sky of telescope's site. Moreover a learning environment to learn the structure, behavior and function of telescopes were developed in virtual world. The remote telescope system is easy to use, so that it neglects chance to learn how to use the telescope. In science education, it is also important to teach how to use equipments. The learning system compensate for it.

Keywords: **Remote Telescope, Virtual Observatory, Astronomical Educaion**

1 Introduction

We have developed a remote telescope system in a public observatory in Japan [1]. This first version has a web based user interface, and remote student can use the system from remote site via Internet. If the client site has certain time difference between Japan, the student can see live picture of the celestial bodies in daytime. Moreover the student can operate the telescope as he/she wishes by using slight motion buttons on the web based user interface. This first version was the world first interactive remote telescope which offers live picture on a web user interface in 1997, though a remote telescope offering still image was made before[2].

Although the first version of the remote telescope system were quite successful, it has some problems. The system does not have the function for exclusive control. The exclusive control is necessary in the multi-user environment, because more than two clients cannot use the system simultaneously. On the first version, the student must promise the date and time of the usage in advance.

Another problem of the first version is that the telescope is too huge (105cm reflector) to use as a remote telescope. Besides the dome of the observatory is not controlled from remote site. Therefore the staff of the observatory must always help the usage.

We are now developing second version of remote telescope system to solve the problems of the first version. The second version uses small telescope (Meade LX200 20cm reflector), so that it is easier to use as a remote telescope.

The second version has a scheduling system, which can work as the exclusive control. Clients can reserve the date and time of usage of the remote telescope on a web page for scheduling. The system has 3D planetarium as well as web user interface. The planetarium shows what can be seen in the real sky where the telescope is located. Moreover the second version supports vertual environment to learn structure, behavior and function of various types of telescope. These virtual planetarium and virtual environment for learning are regarded as virtual observatory. Although today some other remote telescopes has been developed in the world [3-6], our remote telescope is unique which supports virtual observatory.

2 Scheduling system

The scheduling system was developed for multi-user usage (Fig.1). It has two important function. They are exclusive control system and reservation system. Exclusive control system enables to permit usage by only one client at every time. If a student tried accesses to the system during the usage by another student, the exclusive control system reject it, and make him/her wait until the superior student terminates the usage. Reservation system enables to reserve date and time of usage in advance. The reserved usage is superior to non reserved usage, so that non reserved usage is terminated by force when it is the time of reserved usage.

The scheduling system is made by using CGI(Common Gateway Interface), and the CGI program works by a scheduling web page on a public directory. Clients' information such as account information and reservation information, is preserved in a file in the scheduling system. Since the file includes very important contents, it must be protected from illegal access. The file is not on the public directory, but on a private directory to which cannot be had access. The security is kept by this method.

Fig.1 Scheduling system

3 Live picture

The live picture of celestial bodies enhances students' learning of astronomy (Fig.2). There are two methods to send live picture. One is by stream, the other is by still image series. We are currently using the latter way. SGI O2 Unix workstation is used as a camera server. O2 has a program which takes still image with CCD camera. Our system utilize the program, and automatically save JPEG picture in every three second into a same file in the camera server. We also developed Java applet which has access to the file, and read it, then display the still images continuously. Remote clients can see live picture as if it is animation.

4 Remote control of the telescope

A student can control the telescope from remote site. In the first version of the remote telescope system, we used CGI to control the telescope. In the second version, we considered that we would use CGI on a HTTP server, however CGI has the following problems.

(1) When a client terminate usage of the telescope, it is impossible for the server to refuse connection.

(2) More than two clients can have access to the remote telescope system simultaneously at anytime. Therefore it is impossible to realize exclusive control.

Fig.2 Live picture (Example: Moon)

(3) In a collaborating learning, more than two clients have access to the system simultaneously. In this case, the same number of CGI process as the clients' number run in the server, so that the load of the server become heavy.

We used Java applet in order to solve the problems. The merit of communication by Java applet is as follows.

(1)When a client terminates usage of the telescope, it is possible for the server to disconnect the connection.

(2) It is possible to realize the exclusive control.

(3) It is possible for the server to send various information to Java applet at client machine.

By these reason, we developed a telescope control program by Java applet. The procedure of usage is as follows.

(1) A client set a target celestial body, and push the submit button. Then the command to control the telescope is sent to the server program.

(2) The server program receives the command and send it to serial port. Then the telescope receive the command, and it moves to get the target.

(3) The telescope send status to the server, after it finish moving.

(4) The server program send the status to applet at the client machine.

Figure 3 shows the procedure.

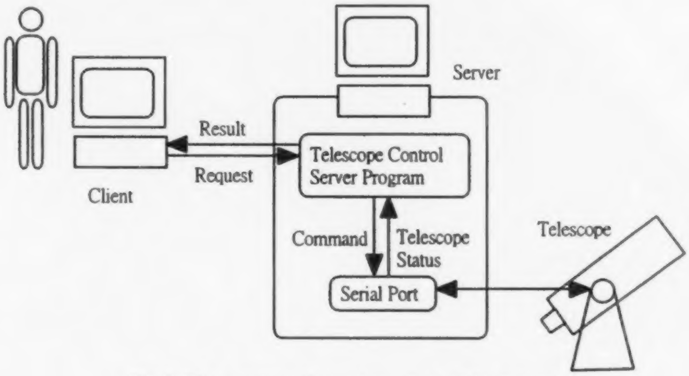


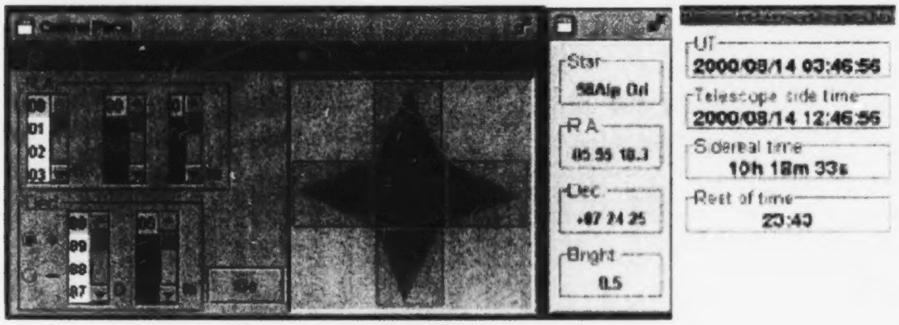
Fig.3 The process of remote control of the telescope

5 Graphical user interface

The GUI of remote telescope system is made by applet. The GUI by applet in second version has the following functions (Fig.4).

(1) To move telescope by setting target's coordinates
(2) To move telescope by selecting a target in a menu
(3) To move telescope by slight movement buttons
(4) To show local time where the telescope is located
(5) To show universal time
(6) To show the rest of the reserved time
(7) To show some information about the target

In the above, functions (1)-(3) are the same as the first version. A student can control the telescope easily by the GUI. The slight movement buttons enable the student to move the telescope slightly, so that the student can scan the celestial body. This function is especially useful when the student observes apparently large target such as the moon. The student can feel as if he/she is traveling over the moon by space ship.



Star: 58Alp Ori
RA: 05 55 10.3
Dec: +07 24 25
Bright: 0.5
UT: 2000/08/14 03:46:56
Telescope side time: 2000/08/14 12:46:56
Sidereal time: 10h 18m 33s
Rest of time: 23:43

Fig.4 Graphical User Interface

6 Virtual Planetarium

The planetarium is made by Java3D (Fig.5). The planetarium reflects the real sky where the telescope is located by calculating sidereal time. Remote clients in all over the world can know what can be seen in the sky at that time at telescope site, such as stars, planets, nebulas, and galaxies. The planetarium also has a telescope model in the center of the planetarium. It is a kind of virtual telescope. The virtual telescope reflects the real telescope. The direction of the virtual telescope indicates that of real telescope. By this function, clients can know easily in which direction the telescope is. Since a beam line from virtual telescope to celestial sphere is shown in the planetarium, the user can easily recognize which star the telescope catches currently. Besides when the user click one of stars on the virtual planetarium, both virtual and real telescopes start to move, and catche the target star.

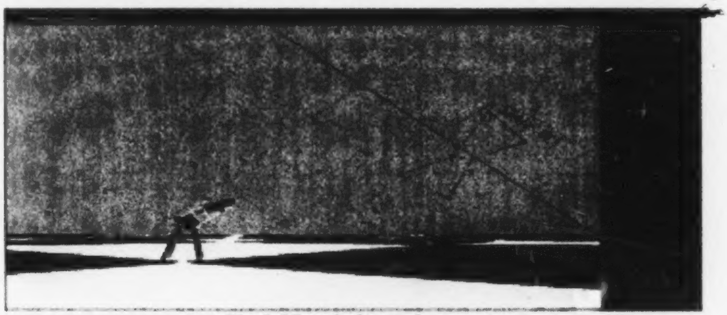


Fig.5 Virtual planetarium

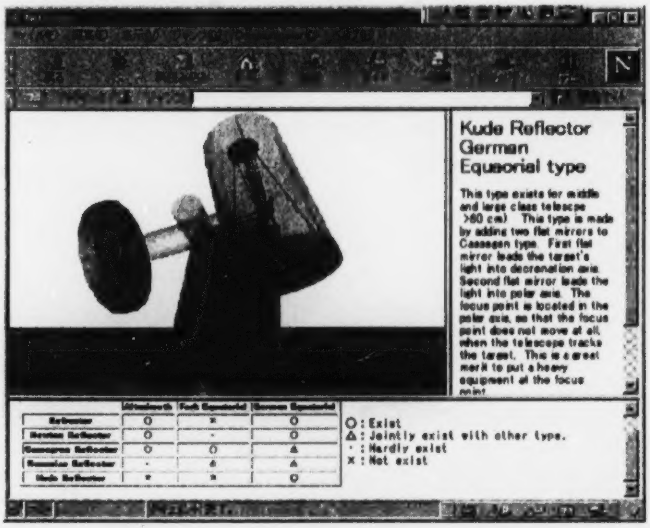
7 Learning environment for learning telescopes in virtual world

In science education, it is important for students to observe target in real world as well as to learn how to use the equipments for the observation. The remote telescope system enables to observe real celestial bodies in the classroom. Nevertheless it neglects to learn how to use telescope. Because students can easily operate the remote telescope system without knowing the structure of the telescope and every function of each part.

We have been developing a system in virtual world, by which students can learn kinds of telescopes, every structure, every characteristics, and every function. The system is made by VRML, and the telescopes in the virtual world can be moved around two axes. The astronomical telescopes are classified optical structure and by mounting structure independently. Therefore the system has a table which shows the combination of optical structure and mounting structure (Fig.6). Some combinations exist and other combinations do not exist. If a combination exists, a circle is filled in the table. If it does not exist, a cross is filled. Triangle means seldom existence, dot means rare existence. This table guides students to every combination. If a student click a symbol (circle, triangle, dot), then the telescope is shown with the combination of optical and mounting structure.

Since the virtual telescopes can be rotated around two axes by mouse dragging, students can learn how to operate telescopes. Besides students can learn the function of every axis by rotating it. For instance, one axis of equatorial mounting is set in the direction to polar star (Fig.7). The telescope can track a celestial target by rotating around the axis, because the celestial target moves in the sky in accordance with earth's self rotation.

Moreover the virtual telescopes show optical structure of them, and show ray trace. When the a student rotates a virtual telescope, he/she can know how the focus point of the telescope moves. Students can learn the focus points do not move in some types of telescope. They can know such type of telescope is useful for attaching heavy equipment on the focus point.



**Kude Reflector
German
Equaorial type**

This type exists for middle and large class telescope >60 cm) This type is made by adding two flat mirrors to Cassegen type. First flat mirror leads the target's light into decrenation axis. Second flat mirror leads the light into polar axis. The focus point is located in the polar axis, so that the focus point does not move at all, when the telescope tracks the target. This is a great merit to put a heavy equipment at the focus point.

	[illegible]	[illegible]	[illegible]
[illegible]	○	×	○
[illegible]	○	·	○
[illegible]	○	○	△
[illegible]	·	△	△
[illegible]	×	×	○

○ : Exist
△ : Jointly exist with other type.
· : Hardly exist
× : Not exist

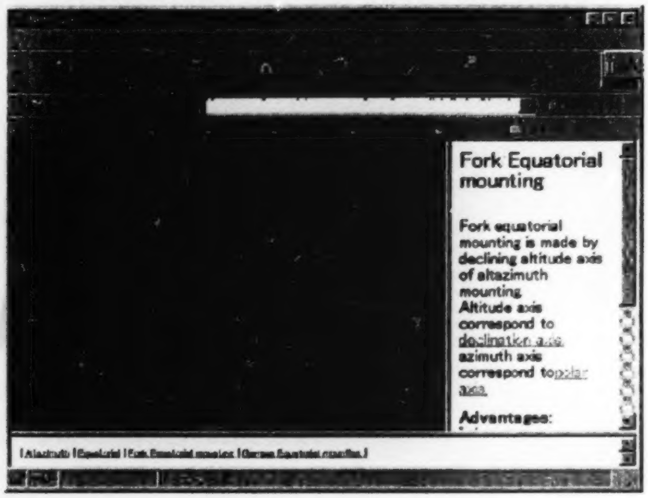
Fig.6 Virtual environment for learning structure and behaviour of various type of telescope

8 Conclusions

In this paper, we described the second version of remote telescope system. We explained scheduling system, telescope control, GUI, live picture, virtual planetarium and learning system. This total system can be regarded as synthesis of real observatory and virtual observatory. The real observatory offers live picture of celestial bodies. The virtual observatory offers planetarium and learning system. In the remote telescope system, students can operate the telescope easily, so that it neglects the chance of learning how to use the telescope. In science education, it is also important to learn how to use the observation equipment. The virtual observatory compensates for it.

The student can observe real celestial objects by real observatory from remote site. If there is time difference between the client site and observatory site, the student can observe real celestial objects in daytime in classroom. It will be a strong tool to learn astronomy. This system brings experimental environment into classroom in astronomical domain.

Our future work is to make dome or sliding roof and to install the telescope in it.



Fork Equatorial mounting

Fork equatorial mounting is made by declining altitude axis of altazimuth mounting.
Altitude axis correspond to declination axis.
azimuth axis correspond to polar axis.

Advantages:

Fig.7 Virtual environment for learning function of parts of a telescope

References

[1]M.Soga, K.Watanabe, T.Tanaka, M.Sakamoto, H.Tanaka, S.Toyomasu, M.Okyudo, J.Arimoto, "A Remote Control System of a Telescope by WWW and Real Time Communication for Astronomical Education", Proc. of World Conference on Educational Multimedia/Hypermedia / World Conference on Educational Telecommunications (ED-MEDIA / ED-TELECOM'98), pp.1305-1310

[2] Mark J.Cox, John E.F.Baruch (1994). Robotic Telescopes: An Interactive Exhibit on the World-Wide Web. 2nd International Conference of the World-Wide Web, 1994

[3] Hands-On Universe, http://hou.lbl.gov/

[4] The CWRU Warner and Swasey Observatory Nassau Station, http://astrwww.cwru.edu/nassau/nassau.html

[5] Remote Access Astronomy Project Remotely Operated Telescope, http://www.deepspace.ucsb.edu/rot.htm

[6] Telescope In Education, http://www.mtwilson.edu/Science/TIE/

Web Speaking: A Language Learning System in the Web

David Lo, Wen-Tsai Liao and Ming-Syan Chen
Department of Electrical Engineering and Computer & Network Center
National Taiwan University
Tapei, Taiwan, ROC

Due to recent technology advances, an increasing number of applications are being ported to the Web at rapid pace. Such applications include Web Phone, Web Fax, Web BBCall, to name a few. Among others, network education has emerged as an important Internet application since it not only avoids the limitation of physical learning locations but also keeps the flexibility of teaching time. In this paper, we develop an interactive language learning system in the Web, called Web Speaking. By using Web Speaking, students are able to learn languages anywhere at any time as long as a Web interface is provided. Web Speaking is in essence a two-tier client-server architecture, and is divided into two components, namely (1) the language learning player at the client-side and (2) the course content provider at the server side. In this system, we put not only the course content but also the corresponding audio files in the server side in order to support a multimedia-teaching environment. The language-learning player runs at the client side and provides a user interface to access the course materials in the server. In addition, Web Speaking is able to improve the language speaking ability of the students with the display of the speech waveform which is generated by using the algorithms isolating the utterances of the speech. Students can capture the difference between the waveforms of their own speaking and the standard one provided by the instructor, and improve their speaking accordingly. By this language learning package, we can automate the procedures of preparing audio course materials, greatly facilitate the language learning by the students, and conduct data mining on student behavior. The teaching quality of language learning can thus be improved.

Keywords: **Distance learning, speech analysis, two-tier client-server architecture, World Wide Web**

1 Introduction

Recently, an increasing number of applications are being ported to the Web at rapid pace, including Web Phone, Web Fax, Web BBCall, and so forth. Among others, network education has emerged as an important Internet application since it not only avoids the limitation of physical learning locations but also keeps the flexibility of teaching time [1,2,3,5,6,7,8]. Traditionally, the students have to be present in the language-learning classrooms and use specific language learning mechanisms to improve their speaking ability. However, the major disadvantage of the traditional language learning is the limitation of time and space. For example, the students may have an English class in the Monday morning at the language-studio classroom and that class could be their sole opportunity to practice their language speaking, since the instructor is only present at that moment. Consequently, the effectiveness of the traditional language-learning systems is limited.

In this paper, we develop an interactive language learning system in the Web, called *Web Speaking*. The Web Speaking system we developed in the Computer and Network Center at National Taiwan University is in essence a two-tier client-server architecture. Through a Web interface, the students are able to not only learn the lessons anywhere at any time but also practice their speaking at leisure pace, thus overcoming the limitation imposed by time and space. In addition, using Web Speaking, students can communicate with the instructors interactively via the mechanism provided, and the teachers can timely edit the course materials by writing the content of text and recording the audio files in response to the students' requests very easily. These are the very advantages of Web Speaking over some stand-alone commercial language-learning applications which are usually lack of interactive features.

In addition, the other major contribution is to provide the displays of the speech waveforms produced by the teachers and the students to help the students to learn language speaking better. In Web Speaking, we implement the algorithms isolating the utterances of the speech [9,10] to improving the students' speaking ability. Through the display of the speech waveforms, students can perceive the difference of the speech waveforms between their own speaking and the one prepared by the teacher, and improve their speaking accordingly by themselves.

Web Speaking has been distributed to some language learning groups in our campus for experimental use and been well received thus far. It is worth mentioning that Web Speaking system is meant to help the teachers to improve their teaching quality, and should be viewed as an auxiliary tool for teaching. By no means do we assert that Web Speaking is able to completely replace the role of an instructor or in any way to lessen the need for a teacher to personally interact with students. We believe that by exploiting the availability of Internet, Web Speaking is very instrumental to the traditional in-class teaching and will improve the quality of teaching results significantly from both the perspectives of students and instructors.

The paper is organized as follows. Section 2 depicts the whole system architecture. Section 3 presents the implementation and functionality of the Web Speaking. Section 4 concludes this paper.

2 The System Architecture of the Web Speaking

We use a two-tier client-server architecture for the Web Speaking system. The reason of using the two-tier client-server architecture is that it can provide our two key components, i.e., the language-learning interfaces at the client side and the course content provider at the server-side. This architecture can be easily extended to a three-tier one if an additional gateway is required in this application.

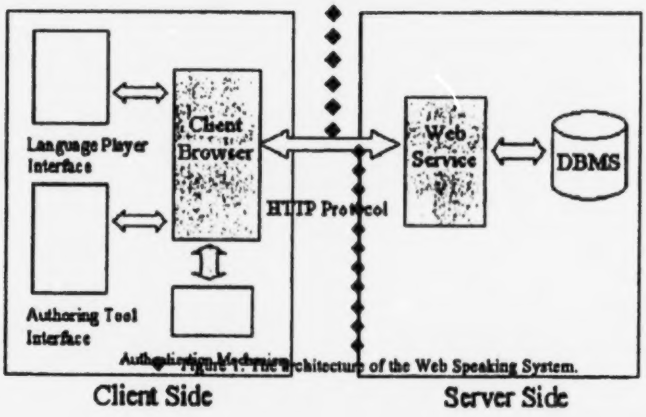


Figure 1: The Architecture of the Web Speaking System.

Based on the two-tier client-server architecture, the Web Speaking System is designed as the Figure 1. At the client side, both the language player interface and the authoring tool interface use the DBMS (Database Manager System) to access the course materials in the server via the HTTP protocol in the Internet/Intranet. The program at the serve side then accepts the requests from the clients and returns the results of the requests to the clients. The DBMS at the server side saves not only the course materials but also the information of the users, including the students and the teachers. Using an authentication mechanism, the player is able to verify the user identification via the Web and to provide different user interfaces for students and teachers, as one form of personalized service. For instance, the students are only allowed to use the language player interface whereas the teachers can use both the language player interface and the authoring tool interface. The following subsections will introduce the operations of the Web Speaking System briefly.

2.1 The language learning player at the client side

To assist the students in language leaning on listening and speaking, the user interface (UI) of Web Speaking provides the functions of playing the audio files and those of recording the user's voice. Furthermore, the UI displays the wave shapes of the audio files and the user's voice for users to capture the differences and to improve their speaking. For example, once the user selects one topic of the course in upper-left area of the Figure 2, i.e., "There are always two sides to everything." In Figure 2, not only will the content be shown in the upper-right area but also the shape of this audio appears in the middle area. When the users are playing back the audio in the middle area, an indicator will run along the shape of the audio to indicate the exact timing of audio playing.

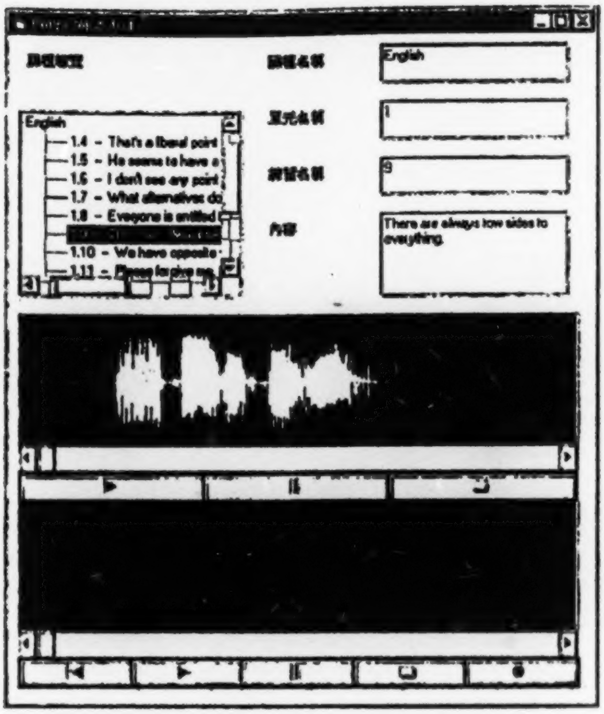
In addition to listening the audio and watching the shape of it, the users are also able to record their voice into the system, play it out, and compare its shape with the standard one in the course material. In order to prepare the course materials easily and automatically, Web Speaking provides an interface to authorize the use of course materials and to upload and download materials automatically from the course content provider. This is a very convenient feature for the teachers who are not familiar with the operations of the transmitting files in the Web. Furthermore, the teachers could edit the content of the course material and record the audio easily via this interface, such as adding a new topic of the course material or creating a new course in the upper-right area in the Figure 3. They can also playback and record the audio file of the course materials in the bottom area. As such, the language-learning player, including the language learning interface and the course material authoring tools interface, runs at the client side and provides a user interface to access the course materials in the server. In addition, we use the algorithms isolating the utterances of the speech to display the speech waveform in order to facilitate the language learning of students.

Note that the user needs to use the local resources, such as the I/O of the audio interfaces and the I/O of the storage interfaces at the client side. However, this I/O access is not allowable for the browsers, such as the Internet Explorer and the Netscape Navigator. Therefore, we implement a stand-alone language-learning program at the client side by using the Microsoft Visual Basic 6.0 programming tools.

2.2 The course content provider at the server- side

The major tasks of the server are to save and update the teaching materials and to query the databases when so necessary. These tasks are implemented by using the PHP script language and MySQL database at the server side. Since the PHP script language has been integrated with MySQL database, we use it to query the databases (MySQL). The client can then use the HTTP protocol to communicate with the server.

The course content provider is mainly a server combining the Web service and the database manager. It employs the PHP script language to access the MySQL database and to response the client's requests. As mentioned earlier, the server side of Web Speaking saves not only the contents of the courses but also the corresponding audio files in order to support a multimedia-teaching environment. Once the server gets a request, the content provider fetches the requested materials by the user from the database, and then, if the corresponding authentication succeeds, returns the result to the client.



English
- 1.4 – That's a liberal point
- 1.5 – He seems to have a
- 1.6 – I don't see any point
- 1.7 – What alternatives do
- 1.8 – Everyone is entitled
- 1.10 – We have opposite
- 1.11 – Please forgive me

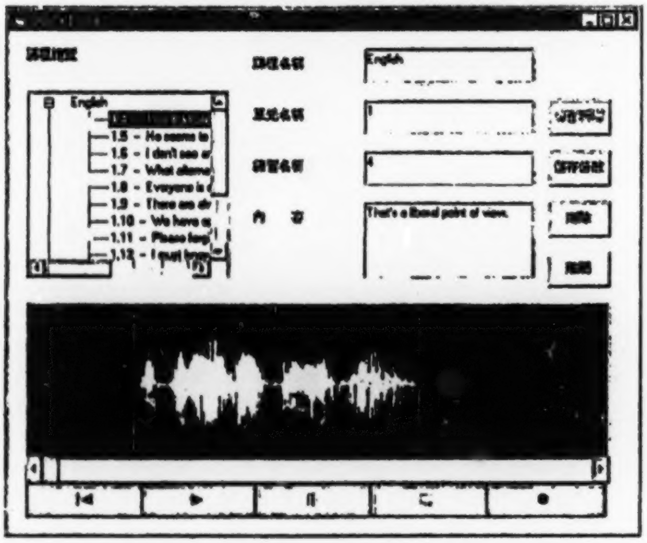
English

1

9

There are always tow sides to everything.

Figure 2: The language-learning player for the students



English
- 1.5 – He seems to
- 1.6 – I don't see a
- 1.7 – What alterna
- 1.8 – Everyone is
- 1.9 – There are al
- 1.10 – We have o
- 1.11 – Please forg
- 1.12 – I must

English

1

4

That's a liberal point of view.

Figure 3: the authoring tools for the teachers

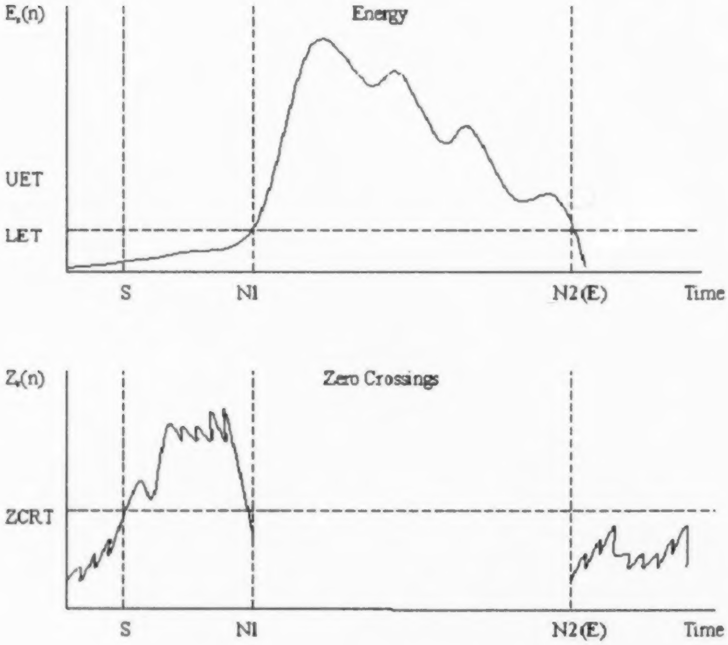
3 End Point Detection for Speech in Web Speaking

We introduce in this section the algorithm used to detect the endpoints of isolated utterances. To help the user learning the language speaking, we display both the waveforms of the speech produced by the user and the standard one prepared by the teacher. In addition, we isolate the utterances of the speech to help the user to understand how the speech looks like. This endpoint detection method [10] uses two parameters, i.e., the short-term energy ($E_s(m)$) and zero crossing rate ($Z_s(m)$), to detect the endpoints of an utterance. These two parameters are calculated as follows, where s(n) means the speech signal, w(n) means the window function, and N means the length of the window.

$$E_s(m) = \sum_{n=m-N+1}^{m} s^2(n)$$

$$Z_s(m) = \frac{1}{N} \sum_{n=m-N+1}^{m} \frac{\left|\operatorname{sgn}\{s(n)\} - \operatorname{sgn}\{s(n-1)\}\right|}{2} w(m-n)$$

$$where \quad \operatorname{sgn}\{s(n)\} = \begin{Bmatrix} +1, & s(n) \geq 0 \\ -1 & s(n) < 0 \end{Bmatrix}$$



◆ Figure 4: Illustration of the endpoint detection algorithm.

The endpoint detection algorithm is depicted in Figure 4 and described below.

Step 1. Assume that the window function *w(n)* is a rectangular function with the window size *N* being 10 ms, and the first 100 ms of the speech signal is background noise. Then, use this signal segment to calculate the mean and variance of $E_s(m)$ and $Z_s(m)$.

Step 2. Using the statistics derived from Step 1, determine three thresholds, i.e., the upper energy threshold (UET), the lower energy threshold (LET), and the zero crossing rate threshold (ZCRT).

Step 3. Search from the beginning until the energy $E_s(m)$ exceeds the threshold UET. Then, run backward until the energy $E_s(m)$ falls below the threshold LET. We call this point the tentative beginning point N1. The tentative ending point N2 is calculated in a similar way.

Step 4. From the tentative beginning point N1, we examine the zero crossing rate for the previous 250 ms signal segment. If there are more than three occurrences of counts above the threshold ZCRT, we select the first point backward from N1 whose zero crossing rate is higher than ZCRT as the beginning point (S) of the word. If there are no more than three occurrences of counts above the threshold ZCRT, the tentative beginning point N1 is directly selected as the beginning point of the word. The ending point (E) is decided in a similar way with exception that the forward searching direction replaces the backward one.

By using the above algorithm we can partition the waveforms of the speech. Furthermore, the language-learning player displays the shapes in the screen and also indicates the timing when the waveform of the speech plays. Thus, this functionality of the language-learning player offers not only the playout of the audio but also the display of the waveform shapes at the same time. This is a very helpful feature for students to learn language speaking.

Note that we can collect students' practicing records in the Web Speaking system. Through some data mining techniques, we can find useful information about the student behaviors, e.g., the common mistakes made by the students. Clearly, using such information discovered, the instructor is able to improve their language teaching by reminding the students of how to speak better when the students encounter common problems.

4 Conclusions

In this paper, we developed a Web Speaking system to improve the language learning and teaching for the students and the teachers. By using Web Speaking, the students are able to not only learn the lessons anywhere at any time but also practice their speaking at leisure pace, thus overcoming the limitation imposed by time and space in traditional teaching environments. The advantage of Web Speaking over some stand-alone commercial language-learning applications lies in the full interactivity Web Speaking provides. The other major contribution is to provide the displays of the speech waveforms produced by the teachers and the students in order to help the students to learn language speaking better. Through the display of the speech waveforms, students can perceive the difference of the speech waveforms between their own speaking and the one prepared by the teacher, and improve their speaking accordingly by themselves.

Web Speaking has been distributed to some language learning groups in our campus for experimental use and been well received thus far. We believe that by exploiting the availability of Internet, Web Speaking is very instrumental to the traditional in-class teaching and will improve the quality of teaching results significantly from both the perspectives of students and instructors.

Acknowledgement

The authors are supported in part by the Ministry of Education Project No. 89-E-FA06-2-4-7 and the National Science Council, Project No. NSC 89-2219-E-002-007 and NSC 89-2213-E-002-032, Taiwan, Republic of China.

References

[1] E. Bilotta, M Fiorito, D. Iovane and P Pantano, "An Educational Environment Using WWW", Computer Networks and ISDN Systems, 27, pp. 905-909, 1995.

[2] "CEIBA," High Performance Computing Lab of Department of Electrical Engineering of National Taiwan University, ftp://www.cc.ntu.edu.tw/pub/Webcourse/.

[3] J. Chang, M. S. Chen and I. P. Lin, "Design and Implementation of a Software Package for Network Education", Proc. of the 2000 International Conference on Engineering Education, August 14-16, 2000.

[4] M. S. Chen, J. Han and P. S. Yu, "Data Mining: An Overview from Database Perspective", IEEE Trans. on Knowledge and Data Engineering, Vol. 8, No. 6, pp. 866-883, December 1996.

[5] "Distance Learning in National Taiwan University", National Taiwan University, http://www.cc.ntu.edu.tw/~ccdl.

[6] D. Dwyer, K. Barbieri and H. M. Doerr, "Creating a Virtual Classroom for Interactive Educations on the Web", Computer Networks and ISDN Systems, 27, pp. 897-904, 1995.

[7] B. Ibrahim and S. D. Franklin, "Advanced educational uses on the World Wide Web", Computer

Networks and ISDN Systems, Vol. 27, No.6, Apr. 1995.

[8] J. C. Jehng, Y.F. Shih, S. Liang and T. W. Chan, "TurtleGraph: a computer supported cooperative learning environment", The Proceedings of the World Conference on Educational Multimedia and Hypermedia, Vancouver, Canada, AACE, pp.293-298, 1994.

[9] M. C. Lai, B. H. Chen and S. M. Yuan, "Toward a new educational environment", World Wide Web Journal, Issue One: Conference Proceedings, Fourth International World Wide Web Conference, O' Reilly & Associates, Inc., pp. 221-230, Nov. 1995.

[10] L.R. Rabiner and M.R. Sambur, "An Algorithm for Determining the Endpoints of Isolated Utterances", The Bell System Technical Journal, Vol. 54, No. 2, February 1975, pp. 297-315.

Web-Based Learning Portfolio (WBLP): An Electronic Authentic Assessment Tool on Web

Chi-Cheng Chang
Graduate Institute of Technological and Vocational Education
National Taipei University of Technology
No 1, Sec. 3, Chung-Hsiao E. Rd., Taipei, Taiwan 106
Fax: +886-2-27812897
E-mail: samchang@mail.tku.edu.tw

A web-based learning portfolio (WBLP) for authentic assessment has been constructed, in the hope to help record, display, search and analyze student learning process data. The WBLP system has been officially implemented in a course at the university for a semester. The results of the system evaluation and effects show that most students consider that the system is helpful to improve the learning process and accomplishing quality, to understand the authentic learning process and outcome, to provide chances for displaying and improving works.

Keywords: **Portfolio, Portfolio Assessment, Web-Based Portfolio, Electronic Portfolio**

1 Research Background

The negative impacts of the traditional paper-and-pencil assessment method are commonly found in researches by scholars in Taiwan and abroad. These contain examination-oriented instruction and the inability to assess high-order cognitive abilities and affective attributes in common (Herman, 1992; Glaser & Silver, 1994). However, the defects that do not comply with contemporary learning theories are not only criticized by many scholars but also provide a theoretical foundation for the improvement of traditional assessment and creation of new assessment methods. From the viewpoint of recently developed constructivist learning theory, knowledge should not be accepted passively, it should be actively constructed by cognition. Therefore, instead of using simple knowledge instruction, an instructor should be a facilitator and adviser of instruction to help learners create a knowledge construction environment. The instructor should give guidance and support, in order to help learners become actively involved in the learning process and construct their own knowledge. Furthermore, situational cognition claims that learning should be applied to real life situations and emphasize on student involvement and understanding in the learning process.

Traditional assessments, which are made according to the student's memory of the message given by the instructors, are unable to effectively measure the results of these two learning theories. The changes in the student's cognition and learning process, involvement and interaction have become the new foundation for learning effect assessment. Traditional assessment does not effectively measure students' ability to organize relevant information or present a coherent argument, and lack sensitivity to the individual growth that teachers desire in students (Cole & Ryan, 1995). Therefore, when traditional assessment is unable to effectively reflect a student's learning process, there is a need for new types of assessment. In response to the needs of the new learning theories such as constructivist learning, and to improve upon the insufficiency and limitations of traditional assessments, new assessments come out one after another in various forms and names.

Based on the aforesaid beliefs and importance concerning learning portfolios, this research designed, constructed and evaluated a learning portfolio on the World Wide Web architecture according to the portfolio assessment concept by combining the characteristics and functions of computer and network technology. Furthermore, this portfolio was conducted on a subject at the university to evaluate its functions and effects. The objectives of the research are:

1. To design and construct a web-based learning portfolio that satisfies the needs of university students in Taiwan.
2. To assess the functions and effects of a web-based learning portfolio and its impact on learning of students.

2 Functions of WBLP

The WBLP system is built upon an Intel Pentium-II CPU system and MS Windows NT Server 4.0 Operation System. The Web server uses the MS Internet Information Server (IIS) 4.0, and the database uses the MS Access 97. In addition, MS FrontPage 98 was used to create basic page layout and hyperlink architecture for web pages and MS Visual InterDev 6.0 was used as an assistant tool for system function development and ASP (Active Server Page) programming. System development and construction were conducted right after the determination of tools. The functional architecture of the WBLP system is shown in Figure 1.

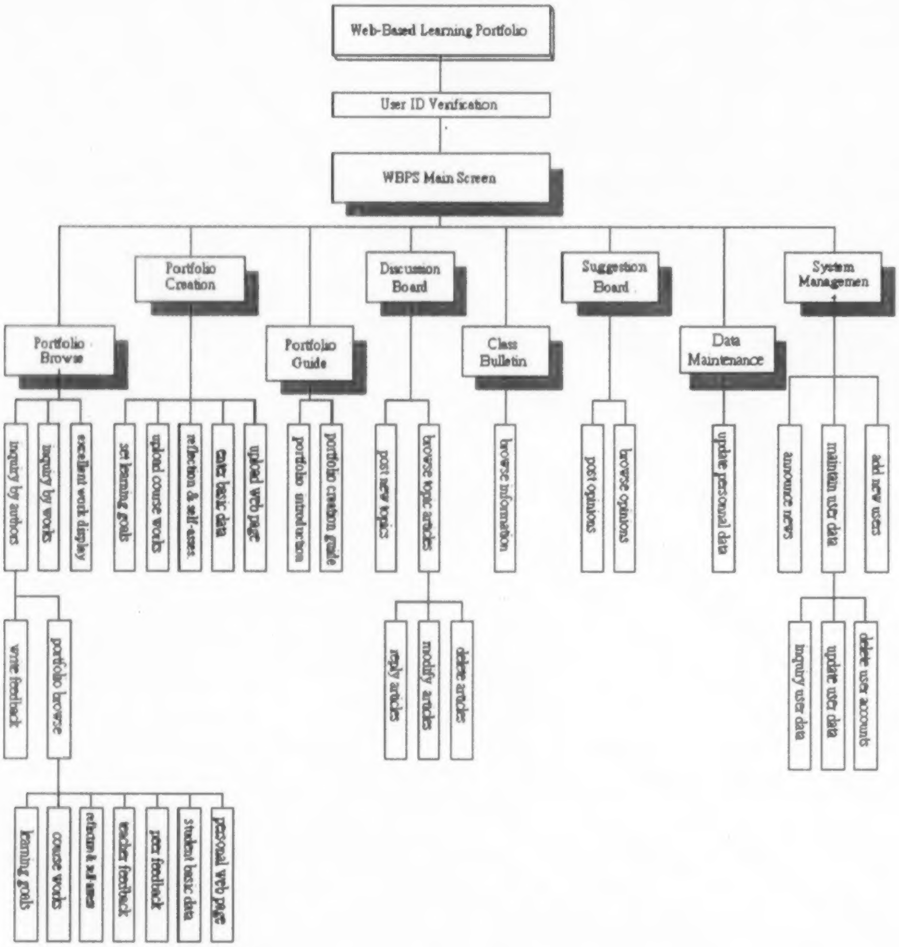

Web-Based Learning Portfolio
User ID Verification
WBPS Main Screen
Portfolio Creation
Discussion Board
Suggestion Board
System Management
Portfolio Browse
Portfolio Guide
Class Bulletin
Data Maintenance
inquiry by authors
inquiry by works
excellent work display
set learning goals
upload course works
reflection & self-asses
enter basic data
upload web page
portfolio introduction
portfolio creation guide
post new topics
browse topic articles
browse information
post opinions
browse opinions
update personal data
announce news
maintain user data
add new users
write feedback
portfolio browse
reply articles
modify articles
delete articles
inquiry user data
update user data
delete user accounts
learning goals
course works
reflection & self-asses
teacher feedback
peer feedback
student basic data
personal web page

Figure 1 Functional architecture of the web-based learning portfolio

2.1 User ID Verification

BEST COPY AVAILABLE

The target users of this study were students and teachers in a Computer and Instruction course for the Teacher Preparation Program at one university. A user ID verification was established to identify the users. A guest account was also assigned to allow interested visitors to browse students' learning portfolio.

2.2 Portfolio Creation

The WBLP system aims at enabling students to produce their personal learning portfolios fast and easily through the interface provided by the system. Students create the portfolios with the purpose of proving their learning, and concretely demonstrating their efforts and outcomes. Students can use the WBLP system to complete learning goal setting, course work upload, reflection and self-assessment record writing, data basic setting and modification, and personal web page upload by filling out the forms (see Figure 2).

Allowing students to upload their ongoing or completed works in the WBLP system aims at concretely representing their efforts and accomplishments as well as examining and analyzing their works. According to the rationales of portfolios, they must contain students' in-progress and completed works as well as their self-reflections and self-assessments on both their learning and the selected works. Unfinished work might be placed in the portfolio to identify a problem area, and to prompt the student to reflect why it is a problem and what might be down about it. For today' s students to be self-determining, they must self-set learning goal, self-monitor, self-reflect and self-evaluate. Allowing students to write their self-reflection and self-assessment statements in the WBLP system aims at providing them with the opportunity to profoundly reflect on their learning process and outcomes. According to Cole, Ryan, & Kick (1995), allowing students to have decision-making power about the selected artifacts may make the students feel ownership of the portfolio.

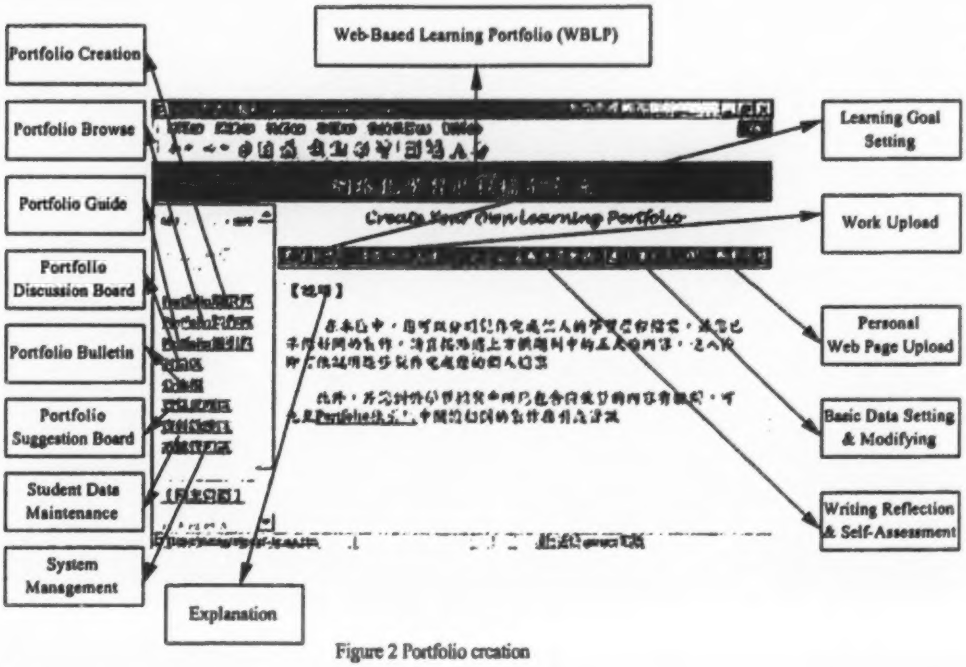

Web-Based Learning Portfolio (WBLP)
Portfolio Creation
Portfolio Browse
Portfolio Guide
Portfolio Discussion Board
Portfolio Bulletin
Portfolio Suggestion Board
Student Data Maintenance
System Management
Explanation
Create Your Own Learning Portfolio
Learning Goal Setting
Work Upload
Personal Web Page Upload
Basic Data Setting & Modifying
Writing Reflection & Self-Assessment

Figure 2 Portfolio creation

2.3 Portfolio Browse

A user may inquire or browse any portfolio by student name. Both students and teachers can browse the contents of individual student portfolios. Browsing areas include learning goals, course work, reflection and self-assessment records, teacher feedback, peer feedback, basic data, and personal web page. A user may also inquire/browse any portfolio by works. Both students and teachers can directly browse the contents of the work. Moreover, both teachers and students may add their feedback and grades while browsing the portfolio. Teachers can use the portfolio-browse mechanisms in the WBLP system to collect interim evidence to identify the students' stumbling blocks and to document the movement toward mastery. In additions, teachers can identify areas of strengths and weaknesses by viewing the whole working processes of the students. For students, they might gain a clear view of their peers' learning processes for reference and thus benefit on their learning.

2.4 Portfolio Guide

The guide provides information concerning the creation of a learning portfolio, including (1) content selection: contents of portfolio according to teacher requirements or group discussion; (2) assessment criteria: criteria of assessment done by teachers ant students together; (3) portfolio creation guide: brief description of rules to be followed for portfolio creation. The contents of this function are subject to adjustment nonetheless they aim at helping students to create their own portfolio. Teachers and peers might provide students with guidance about selecting content of a portfolio, decide assessment criteria, and creating portfolios as well as clarifying why they have identified them as such.

2.5 Portfolio Discussion Board

Provides an asynchronous discussion channel for students to discuss things related to the course and the creation of a learning portfolio. The main issues can be: (1) portfolio content selection criteria; (2) portfolio assessment criteria; (2) portfolio creation manner; and (4) course contents: issues relate to the course. The portfolio becomes a focal point for student-teacher and student-student discussions about issues that have been raised in the learning process. The discussion regularly enables the teacher to talk with students about their growth and reflections. This kind of sharing between teacher and student may be ongoing on the World Wide Web. Farr & Tone (1994) claim that student-teacher discussion is key to the success of portfolio assessment and a vital part of the portfolio methodology. In this kind of exchange and sharing, portfolio assessment likely becomes a key and effective instructional activity. Some teachers have argued that scheduling conferences is quite needed, but conducting them is one of many difficulties in the implementation of successful portfolio assessment (Farr & Tone, 1994). The conferences that the teacher schedules with each student in a traditional way are sometimes expensive to be conducted due to the factors of time and place. In indeed the student-teacher interaction does not need to regularly happen only at scheduled time periods, it can occur informally and frequently, even daily via the WBLP on World Wide Web.

2.6 Portfolio Bulletin

To provide the latest information and news, including system notice, portfolio activities, course information and news. Portfolio activities might include setting learning goal, uploading works, writing reflection and self-assessments, displaying excellent artifacts, writing peer-assessment statements, viewing peers' portfolios and works, and so forth. In order to motivate students, teachers might announce a variety of assessment procedures as scoring students' portfolios, or a regular time period for examining portfolios and rating the content within.

2.7 Portfolio Suggestion Board

This is a communication channel between students and teachers as well as between students and a system manager to enable students to receive feedback on their problems, opinions and suggestions about the WBLP system and portfolio creation. It is also a place for students to share their feelings and experiences about portfolio creation and usage. Students can also use the suggestion board to present options about instruction.

2.8 Student Data Maintenance

To enable students to browse, update and modify their personal data. These data include name, major, telephone number, e-mail address, post address, personal interests, and personal specialties.

2.9 System Management

Exclusive for teachers or the system manager to add new user accounts and to manage student data, including inquiry, browse, modification, add, and delete student data. In addition, teachers or system manager can directly announce news by filling out the form.

3 Database of WBLP

The design of the database is crucial to the smooth operation of the entire system. Three databases were designed to store and manage students' learning portfolios

3.1 Portfolio Database

The portfolio database is the core section of the WBLP system and the place for storage and management of student learning portfolios. Different application goals (such as supporting multiple courses, more classes but one course) of a web-based portfolio lead to various complexity in the considerations of database design. Due to the limits on time and labor, the system presently can simply handle the course load for one class. The student ID number was used as primary index for the portfolio database. The database contains three data tables, which are associated with the student ID.

1. Student data table: stores student basic data, e.g., name, ID number, major, interests, and specialty.
2. Portfolio data table: stores the contents of student learning portfolio, including learning goal, course work, reflection and self-assessment record, teacher feedback record, peer feedback record, and personal web page; where only the learning goal is stored in memo form, the course work column gives the total number works, while only respective filenames are stored in the rest of the columns.
3. Course work data table: in consideration of the differences of works within the student learning portfolio, the record of the table will be updated dynamically when students upload a new work. Data include work-file path, work outline, date of update, status of completion, and grade of works.

3.2 Discussion Database

It is an independent database specially designated for the portfolio discussion board, including two main data tables:

1. topic data table: store information and contents related to the topic of discussion.
2. article data table: store information and contents of articles of discussion, associated by the column of Title ID with the topic data table.

3.3 Bulletin Database

It is designated for the portfolio bulletin board containing only one news data table to store system notices, course information and news as a dynamic message announcement and presentation for teachers and system manager.

4 Implementation and Evaluation of WBLP

4.1 Implementation

The WBLP system was implemented during the middle of second term of the 1998 school year (late April to middle June). The revised and updated prototype system is open to 35 undergraduate students taking the Computer and Instruction course of Teacher Preparation Program until the summative evaluation of system for a period of one and a half month. The implementation and operation are generally good. As the learning portfolio is a new assessment, and through the use and creation of personal learning portfolio, a student can personally experience the assessment and process to understand the nature and contents of the method, which is helpful to the future instruction work of pre-service teachers. Moreover, most assignments and works of the course are presented in electronic data/file, they are very suitable for the creation, management and presentation of web-based learning portfolio. Therefore, the course has been selected as a subject of the system.

As portfolio assessment is new, most students do not have the idea or experience of the assessment. Before the implementation, the students were given a brief introduction to the assessment, so that they could have a better understanding of the portfolio assessment. In addition, an online help/guide is provided in the WBLP system to help users understand the functions, contents and creation of a learning portfolio. After the system implementation, teachers required and encouraged students to use the system according to the course schedule, and subsequently to complete the creation of personal learning portfolio. Moreover, each student is required to write a reflection and self-assessment for each course work, though feedback and assessment on peers' work is not compulsory. At the same time, online assistant has helped teachers to view and numerate the creation of portfolio, learning goal, reflection and self-assessment record, peer feedback and assessment, and student works.

4.2 Evaluation of Functions and Effects

The system summative evaluation includes user-based and expert-based evaluations in terms of system functions, overall design and interface operation, implementation and uses, and impacts on learning.

4.2.1 User-based Evaluation

A survey using a 5-point rating scale questionnaire was given to the 35 undergraduate students in the subject course. Then a random sampling was used to select 5 students for further interviews to have an in-depth understanding of the system function design and learning portfolio creation.

In system function design, besides a lower agreement to the personal web page upload (average 3.75), all other items have an average over 4, which shows that there is still room for improvement in the system upload process. The majority of students agreed and very much agreed, which means that the system functions can satisfy the needs of users. The reasons for the lower agreement of web page upload may include the inability to support upload by directory of data file, a user may need to upload web pages file by file, which makes things very inconvenient; moreover, most students are inexperienced to web page creation and fail to following the instructions of producing web pages, as a result, access paths of web page files are incorrect, and web pages are unable to normally display.

In overall system design and interface operation, user agreement is over 4.0, and there is no disagreement, which suggests that the performance in system architecture, screen and window design, color or background layout and ease to operation is quite good.

In system implementation and application, most students would browse the course works and personal web pages of peers (average over 3.5), so students should be encouraged to browse other contents of the portfolio. Possible reasons are the limited implementation period of the WBLP system. It is difficult for a student to create his own portfolio and browse that of all other students. Browsing other students' course works and web pages may help in the creation and improvement of one's own work. Moreover, most students have browsed their own feedbacks from teachers and peers (average over 4). In personal portfolio creation, most students would browse related information provided in the portfolio guide/help (average 4.27). In practice, most student reflected that the creation of personal learning portfolio is time-consuming (44% agreed, average 3.37); however, there is only a slight difference between agreed and disagreed in the writing of learning goal, reflection and self-assessment record, and peer feedback. From the viewpoint of an average under 3, there is little problem.

In impacts to learning, the Table 1 reveals that the following six items have an average over 4.5, which means that the majority agreed. The results show that most users have a positive attitude toward the system's assistance in personal learning process and outcome, i.e., the system can help students in learning the course.

Table 1 Percentages and averages of student agreement in WBLP impacts on learning (n=35)

Evaluation Items	Percentages of student agreement (%)					
	5	4	3	2	1	Average
1.The system enables students understand the achievements of other students	67	33	0	0	0	4.67
2.The system is helpful for learning the course	70	27	3	0	0	4.67
3.The system enables students learn the feedback and suggestions from other students	60	37	3	0	0	4.57
4.Browsing peers' work will be helpful to improve the quality of one' s own	63	30	4	3	0	4.53
5.The system enables students learn the feedback from teachers	63	27	10	0	0	4.53
6.Expectation for the WBLP system in other courses	60	33	7	0	0	4.53

Note. 1.Evaluation items with an average below 4.5 are not included in the table.
2.The numbers of 5, 4, 3, 2, 1 denote a 5-point rating scale with 5 being strongly agree and 1 being strongly disagree.

4.2.2 Expert-based Evaluation

Three experts (including the instructor of the course, portfolio expert and assessment expert) were invited to use the system, and an interview was made after a week.

In the pertinence of portfolio contents, experts expressed that the WBLP system contents has satisfied the basic needs of a learning portfolio, however, more information concerning the things that happened in class or interesting events, literature or presentation data will enrich the system. In addition, the system is designed for the Computer and Instruction course, teacher application is less self-controlled and spontaneous; the content is more ' teacher-guided' , and student involvement is not concerned.

In system functions (e.g., portfolio creation, browse, guide, discussion, bulletin, suggestion and data maintenance), the WBLP system has displayed the characteristics and functions of learning portfolios in general, they are appropriate and support basic learning portfolio creation/browse. However, for the system management function, the teacher' s grading mechanism on student works, automatic recording function, and score statistic functions can be added to facilitate instruction and assessment. A portfolio assessment scoring function can be added to provide student self-assessment, peer-assessment and teacher-assessment mechanisms, e.g., online creation of assessment table, self-assessment table, peer-assessment table, score automatic recording and statistic functions.

In overall interface design and operation, the system is quite easy-to-use, however, some descriptions of how to create portfolio can be clearer, and the display speed of course work is a bit slow and affect the smooth browse of works.

In assistance to student learning and teacher instruction, the WBLP system can provide an effective and appropriate creation and browse environment of learning portfolio, and can help teachers and students to understand the authentic learning process and accomplishment of students. Moreover, it may provide a chance for students to improve their own works and view that of the others, which are very helpful to learning process. However, students present only the completed work in the portfolio, and the process is harder to display. Therefore, if the collection and display of the in-process works of students are enabled, the system can effectively reflect the process of student learning.

5 Conclusions and Future Works

Tradition portfolio assessment still relies on man-made data collection and a writing-centered learning process. The difficulties in data storage, search and management after long-term implementation have become a problem in the development and implementation of portfolio assessment (Mullin, 1998; Smith &

Tillema, 1998; Niguidula, 1993). Fortunately, the impact of computer technology has facilitated the production of electronic or computer-based portfolios, which not only solves the problem of huge amounts of data storage, but also enables students to combine text, pictures, images and sounds to present richer and more diversified file content through multimedia. In addition, computer technology is a great aid to data collection, update and management of electronic portfolio (Lankes, 1995). The creation of an electronic portfolio however requires peripheral devices (such as a scanner to change a picture into digital format), hard disk, diskette, or CD-ROMs, for storage, printers, etc.. In this respect the World Wide Web will become a common solution for recording a learning portfolio. The availability of the World Wide Web will not only facilitate the recording, editing, searching and analysis of learning portfolio data, learners and teachers can also share data with other users through Internet browsing functions.

Making use of the portfolio assessment concept, this study integrated the characteristics and functions of computer and network technology to design and construct a web-based learning portfolio, in the hope to help record, display, search and analyze student learning process data. Besides being an electronic assessment too for supporting teacher instruction, the WBLP system provides functions for students and teachers to browse and understand the authentic learning status of the others to improve the interaction between students and to let students understand the learning performance and progress of their peers. The functions of the WBLP system include portfolio creation, portfolio browse, portfolio guide, portfolio discussion board, portfolio class bulletin, suggestion board, student data maintenance, and system management. Databases used in the WBLP include student portfolio database (including student basic data table, portfolio data table, course work data table), discussion database (including topic data table, article data table), bulletin database (including news data table).

The WBLP system has been officially implemented in a course at the university setting for approximately a semester, both the implementation and operation are quite good. The results of system evaluation and effects show that most students consider that the system to be helpful in improving the learning process and accomplishing quality, understanding the authentic learning process and outcome, providing chances for displaying and improving works. Besides the time-consuming portfolio creation, students hold a positive attitude to the overall operation and instructional application of the system. Next step we will continue qualitative and quantitative experimental studies to further understand more about the true impact of web-based portfolio learning on students' learning process and outcomes.

Acknowledgement

This research was conducted under the support of National Science Council of Taiwan, ROC, project no: NSC 89-2511-S-032-001.

References

[1] Cole, D., Ryan, C., & Kick, F., "Portfolios across the curriculum and beyond", CA, Thousand Oaks: Corwin Press, (1995).

[2] Farr, R. & tone, B., "Portfolio and performance assessment: Helping students evaluate their progress as readers and writers", Fort Worth, TX: Harcourt Brace College Publishers, (1994).

[3] Glaser, R. & Silver, E., "Assessment, testing, and instruction: Retrospect and prospect", Review of Research in Education, No.20, pp.393-419, (1994).

[4] Herman, J. L., "What research tells us about good assessment", Educational Leadership, No.49, pp.74-78, (1992).

[5] Lankes, A. M. D., "Electronic portfolios: A new idea in assessment", (ERIC Digest EDO-IR-95-9) [Online] Available: http://ericir.syr.edu/ithome/digests/portfolios.html, (1995)..

[6] Mullin J. A., "Portfolio: Purposeful collections of student work", New Directions for Teaching and Learning, No.74, pp.79-87, (1998).

[7] Niguidula, D., "The digital portfolio: A richer picture of student performance", (ERIC Document Reproduction Service NO. ED 400 261), (1993).

[8] Smith, K. & Tillema, H., "Evaluating portfolio use as a learning tool for professionals", Scandinavian Journal of Educational Research, Vol.42, No.2, pp.193-205, (1998).

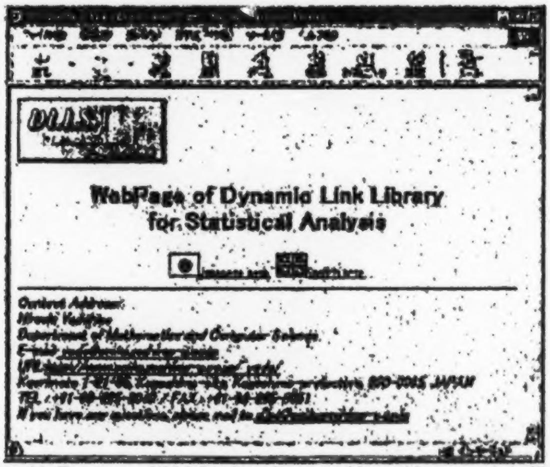
5 Integration

When we use the statistical analysis software, knowledge of statistics is indispensable for us. It can be seen several reports about the effectiveness of the standing statistical analysis software with statistics education [5][7][8][9]. Working statistics with analytical software will much be an expected style of learning over interactive Web system. Under such background, our project team has already prepared a new library of Dynamic Link Library (DLL) for statistical analysis, which is available as a statistical engine or which can be called from existing general statistical software, for examples SAS, SPSS, S and so on.

The DLLs could be considered as a library for applications on the Windows system as well as that for programming. The DLL contains one or more functions that are compiled, linked and stored separately from the applications using them. One of the advantages of DLLs is that multiple applications can access the same DLL. The DLLs in our library can be accessed from any statistical software or spreadsheet-type software if such software has a facility to call functions or subroutines in DLLs. Source codes for DLLs can be written in several programming languages, for examples, C++, FORTRAN, BASIC, PASCAL and so on.

The contents of multivariate analysis section, for example, are as follows. i) Principal Component Analysis, ii) Metric Multidimensional Scaling, iii) Latent Class Analysis, iv) Hierarchical Cluster Analysis, v) Corresponding Analysis, vi) Discriminate Analysis. All contents of our library can be downloaded and used freely. Details for the library and published DLLs can be obtained from our web site (URL: http://www.sci.kagoshima-u.ac.jp/~dllsa/).

The necessary factors of integrated statistical education system of interactive way on Internet are now on ready among our project team members. To be concrete, it is important and urgent to merge statistical analysis software routines above with online learning system on Web as mentioned before, adding to attach the enrichment of interfaces.



WebPage of Dynamic Link Library for Statistical Analysis

Figure 11: Top page of DLLSA (http://www.sci.kagoshima-u.ac.jp/~dllsa/)

6 Future

Though there are not so many reports about this kind of educational system whole over the world, we can meet some excellent reports about interactive education system on Web [11][12][13][14]. One of our mission is the enrichment of the contents. The join forces of lots of faculties belonging to statistics section will demonstrate the strong power for cooperative Web texts production system. Our next target is achievement of "international cooperative project". We have the plan of translating the part of contents to international version. Now we appreciate the joint research with German colleague who had already established interactive Web site [3][14].

Web-Based Subject-Oriented Learning Program on Geophysics For Senior High School

Rong-Kuan Yang* Yi-Ben Tsai and Shi-Jen Lin*****
** Department of Earth Sciences, National Central University, Chung-li, Taiwan,*
e-mail: rk@eqm.gep.ncu.edu.tw
*** Department of Earth Sciences, National Central University, Chung-li, Taiwan,*
E-mail: ybtsai@eqm.gep.ncu.edu.tw
**** Department of Management Information System, National Central University, Taiwan*
E-mail: sjlin@mgt.ncu.edu.tw

Homepages of contents on the topics of Earthquake, Plate Tectonics Theory and Chi-Chi Earthquake in the field of Geophysics have been composed for the subject-oriented learning program for senior high school students. Learning test activities were performed to testify the teaching and learning effect via Internet. The homepage contents bear the characteristics of (1) scientific theory-based descriptions, (2) more local examples, (3) highly relating to common life, (4) more dynamic illustrations, and (5) providing interesting practicing works. The results of subject- oriented learning test activities in this study show that the learning style, learning procedures and the homepage contents are all highly accepted by the participants from senior high school. And the learning effect is obvious as judged by comparing the pre-learning and the after-learning concept diagrams drawn by each individual participant.

Keywords: **subject-oriented learning program, learning test activities, concept diagrams**

1 Introduction

Internet system supplies plenty of knowledge conveniently and quickly, the explorer can achieve the purpose of self-learning by collecting, reading, analyzing and combining different kinds of data via Internet. For the purposes of improving the learning environment, enhancing the teaching quality, and raising the learning effect on Earth Sciences education for senior high school, web-based course contents on topics of Earthquake, Plate Tectonics Theory and Chi-Chi Earthquake in the field of Geophysics have been set up based on the idea of subject-oriented learning program [2]. Senior high school students can not only do the self-learning but also exchange their learning ideas with others through Internet learning system under different conditions of time periods and places. By joining the study results from fields of education, computer technology, geophysics and geology, subject-oriented learning test activities for each specific subject were performed respectively with the participation of volunteered teachers and students from different senior high schools so as to evaluate the learning effect of Internet learning system.

2 Objectives

By especially considering the educational idea of subject-oriented joint learning mode[1], homepage contents were set up. Internet learning test activities were performed by using joint learning software and concept diagram drawing software developed by the computer technologist' s [3]. The major objectives of the study are as follows:

1) Setting up basic web-based contents on Earth Sciences so as to enhance the teaching and learning interests for high school education, the contents may also serve to a better understanding of the earth environment for social people.

2) Setting up the effective searching catalog so as to assist in surveying and collecting related data.
3) Assisting in solving educational problems and improving learning effect through Internet communication system.

3 Subject-Oriented Joint Learning Test Activity

Subject-oriented learning strategy was the major concern in the study. Participants were advised to carry out the learning program by reviewing and collecting related contents through Internet. All the communications were put through BBS posts or e-mails, there were volunteer helpers, college students, to respond all proposed questions from time to time. Team works were important besides individual learning as well, each would share personal learning results with others and came out a group report, individual learning effect was evaluated by comparing the pre-learning and after-learning concept diagrams.

After entering the web site "gepedu.gep.ncu.edu.tw" (Fig. 1), participants would click the right icon to choose the specified subject for the activity. Each one should draw a pre-learning concept diagram by connecting the provided concept terms with proper words after watching the "Miss story" (a short documentary film) prepared for the subject. And then, the major stages for the learning test activity were:
1) Participants were separated into groups of different topics on the specified subject based on his own study interest.
2) Every group set up its study assumptions and strategy; certain assignments were distributed to each individual member of the group.
3) Group members started to survey and collect related data for the topic, and all the working records were kept by using joint learning software.
4) Participants bearing the original role of topic group were re-divided into different groups of experts to cover more study fields. Members discussed and shared personal study ideas and results with others.
5) Each participant returned to his original group of topic and made after-learning concept diagram a group report for the study was also made with the efforts of all the group members.

4 Results and Discussions

Three learning test activities were finished in the study [2]; detailed descriptions of the activities are in Tables 1 to 3. When first learning test activity on Earthquake was being held; related software was not well developed. Internet function was limited to content reviewing. By the time of second learning test activity on Plate Tectonics Theory software was more fully developed, all works were done under Internet environment; more working records were preserved in personal joint learning files for the second and the third activities. All discussions and questions among the students were put through BBS posts and e-mails; volunteer helpers joined the discussions and also answered the questions in time. There are 119 posts from the second activity and 552 posts from the third activity, most of the posts are highly related to the learning program. Each participant finished drawing two concept diagrams in pre-learning and after-learning stages respectively, there are 24 diagrams from the second activity and 46 diagrams from the second activity. And each group had also submitted the group report as required in the learning activity in time, there are 2 and 3 reports for the first and the second activities respectively. Plenty of discussions and notes have also been recorded in the joint learning software in Internet. However, the insufficiency of the Internet system and the learning pressure under traditional education system may interrupt the continuous progressing of the learning program, occasional oral communications seem to be necessary. Though the ability in data analyzing, reducing and deducing may not be well satisfied, students show obvious improvement in the knowledge of the subject as judged by comparing and analyzing the individual pre-learning and after-learning concept diagrams and from group reports.

5 Conclusion

Homepage contents for all the three subjects are highly acceptable to high school students and teachers, most of them confirm with the learning effect of the subject-oriented joint learning program. If the traditional learning pressure would be suitably released, students will be more willing and free to perform self-learning program through Internet learning system even though they are not very well familiar with the operation of the used software.

References

[1] Chen, F. C., "The study of a cooperative project-based learning design in network-based environment", NSC Study Report, NSC-88-2511-S-008-002, pp. 1-8(1999)

[2] Chin B. H., Yang, R. K. and Wang, C. Y., "Development of a learning environment for solid earth (geophysics) through Internet", NSC Study Report, NSC-88-2511-S-008-005, pp. 1-5(1999)

[3] Lin, S. J., Chou, S. C., Chen, Y. M., Chan, T. W., "A study of Internet-based collaborative project learning environment", NSC Study Report, NSC-88-2511-S-008-003, pp. 1-8(1999)

Table 1 Learning Test Activity on Earthquake

Time	1998.5.3, 1 day
Location	computer room in Wuling Senior High School
Participants	12 high school students, 3 high school teachers, 17 volunteer helpers(students and teachers from Department of Earth Sciences, National Central University)
Subject	Earthquake
Group of Topic	Occurrence and Distribution, Intensity and Magnitude
Working Pattern	content reading via internet, one to one oral communication, working processes recorded by volunteer helpers
Evaluation Materials	concept diagram, questionnaires, working records

Table 2 Learning Test Activity on Plate Tectonics Theory

Time	1999.2.27~1999.3.6, 8 days
Location	computer rooms in Wuling Senior High School, ChenSheng High School and National Central University, personal working environments
Participants	6 students and 1 teacher from ChenSheng High School, 6 students and 1 teacher from Wuing Senior High School, 7 volunteer helpers from National Central University
Subject	Plate Tectonics Theory
Group of Topic	Continental Drift, Sea Floor Spreading
Group of Expert	Dynamics, Mechanism, Effect
Working Pattern	Besides software learning on the first day and evaluation meeting on the last day, all the other works were all carried out via Internet.
Evaluation Materials	pre-learning and after-learning concept diagrams, questionnaires, BBS posts, working records in joint learning software, three assignments

Table 3 Learning Test Activity on Chi-Chi Earthquake

Time	2000.2.2~2000.2.26, 25days
Location	computer room in National Central University, personal working environments
Participants	4 students and 1 teacher from ChenSheng High School, 2 students and 1 teacher from TaoYuan High School, 2 students and 1 teacher from Wuling Senior High School, 3 students and 1 teacher from HsinChu Experimental High School, 2 students from ChungLi High School, 5 students from HsinChu High School, 2 students from HsinChu Girls' High School, 2 students from ChenDer High School, 1 students from ChuTung High School, 7 volunteer helpers from National Central University
Subject	Chi-Chi Earthquake
Group of Topic	Mechanism, Analysis, Effect
Group of Expert	Focus, Magnitude, Focal Mechanism, Hazard
Working Pattern	Besides software learning on the first day and evaluation meeting on the last day, all the other works were all carried out via Internet.
Evaluation Materials	pre-learning and after-learning concept diagrams, questionnaires, BBS posts, working records in joint learning software

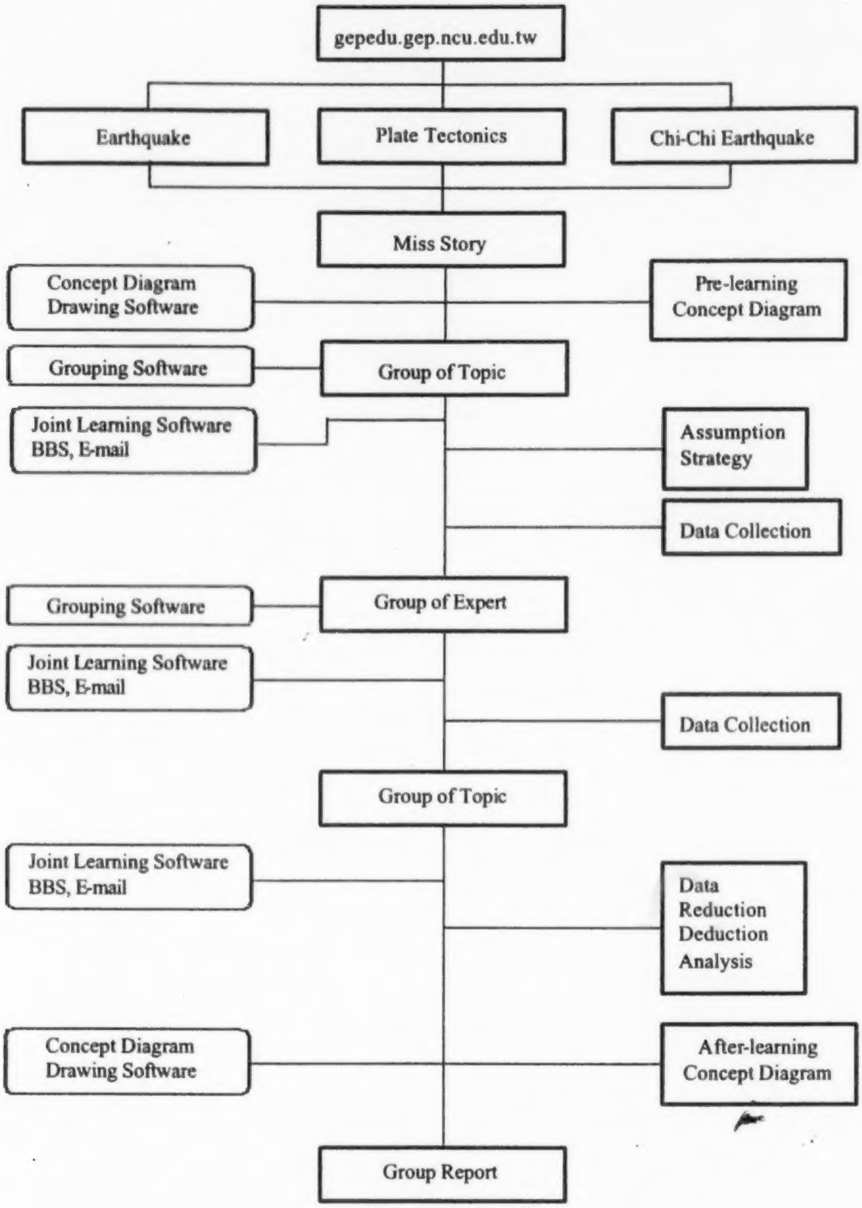

gepedu.gep.ncu.edu.tw
Earthquake
Plate Tectonics
Chi-Chi Earthquake
Miss Story
Concept Diagram Drawing Software
Pre-learning Concept Diagram
Grouping Software
Group of Topic
Joint Learning Software BBS, E-mail
Assumption Strategy
Data Collection
Grouping Software
Group of Expert
Joint Learning Software BBS, E-mail
Data Collection
Group of Topic
Joint Learning Software BBS, E-mail
Data Reduction Deduction Analysis
Concept Diagram Drawing Software
After-learning Concept Diagram
Group Report

Figure 1 Flowchart for subject-based joint learning test activity

WWW-Supported Environments for Learning and Teaching Statistics

Katsuyuki Suenaga*, Hiroshi Yadohisa, Naoko Sakurai***,**
Kazunori Yamaguchi**, Michiko Watanabe*****and Chooichiro Asano********
** Graduate School of Science and Engineering, Kagoshima University,*
Kagoshima 890-0065, JAPAN; sue@sci.kagoshima-u.ac.jp
*** Department of Mathematics and Computer Science, Kagoshima University,*
Kagoshima 890-0065, JAPAN; yado@sci.kagoshima-u.ac.jp
**** Institute of Asia-Pacific Studies, Waseda University,*
Tokyo 169-0051, JAPAN; sakurai@wiaps.waseda.ac.jp
***** College of Social Relations, Rikkyo University,*
Tokyo 171-8501, JAPAN; kyamagu@rikkyo.ac.jp
****** Department of Economics, Toyo University,*
Tokyo 112-0001, JAPAN; michiko@hakusrv.toyo.ac.jp
****** Department of Information Science, Soka University,*
Tokyo 192-8577, JAPAN; QYG04340@nifty.co.jp

In this paper, we introduce an integrated environment for education of Statistics on WWW. The environment is composed of three Web sites; ITLS (Interactive Text for Learning Statistics on WWW), EBSA (Electronic Book for Statistical Analysis on WWW), and DLLSA (Dynamic Link Library for Statistical Analysis). ITLS is an electronic text of Statistics with graphics, sounds, and interactive software which made by JAVA. EBSA is an electronic library of statistical books which made of the PDF format files. These books are scanned and trans-formed from real books which copyright is expired. DLLSA is a statistical software library of DLL files.

Keywords: **Interactive learning environments, Multimedia and hypermedia in education, Self-driven experiments**

1 Background

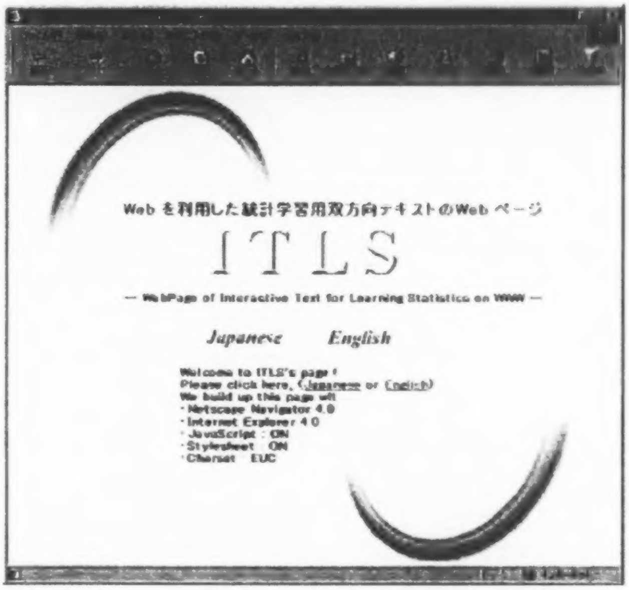
Recent rapid coverage of computer networking over wide area of Japan has brought the big change of education environment at universities. In these 1 or 2 years there can be seen lots of universities, especially in non scientific division, have set up the computer networking education system over their several lectures where both teachers and students can access to internet Web sites during the lecture time. It also can be seen at overseas education institutes that there have been increasing of statistical education sites [11][12][13][14] or related reports [1][3][4][6][10].

On the other hand, the society needs the persons with the ability of economical data analysis or econometrical analysis among the general sections especially in finance division. It means graduates from social sciences department with an ability of data analysis will be much more needed who had not so many times got the lecture related to statistical data analysis during university days. Statistics is good discipline for computer networking education because it is important for students to learn not only the theory but also the moving of practical data with changing parameters which will lead them to another side of understanding of real world. It can be expected that interactive education with internet Web will bring the multi-dimensional effects to education world. Those are why we have started jointly developing new styled education system for statistics on Web site. It also could be seen that the government recommend to make more use of networking at education scene in line with the change of world education environment.

2 Purposes and Functions

The purposes of our statistical education system on Web are as follows. i) Joint development of education Web sites with which practical statistics education can be realized, ii) Non scientific students' master of data analysis for actual practice, iii) Teachers can keep their material for education jointly, aiming contents' standardization, iv) Students can learn everywhere they are. We are aiming students can participate to our Web sites and get effective learning chances of statistics and econometrics with interactive ways. It can be expected students would keep highly motivation of learning through active operation of some parameters or data on Web site by themselves. It is clear that this is quite different from traditional education way at the point of students are active in learning without their realizing.

Let me show the concrete functions. i) Retrieval by keyword and its supplementary explanation, ii) Download of lecture slides and practical data, iii) Linkage to reference sites, iv) Offering of database for practice, v) Setting of question and answer section, vi) Online questionnaires system. In addition, Web texts contain some easy comments, colored contents, hyper linked material, images and dynamic graphs to help students who are far from printing types can understand statistical concepts.



Web を利用した統計学習用双方向テキストのWeb ページ

ITLS

— WebPage of Interactive Text for Learning Statistics on WWW —

Japanese *English*

Welcome to ITLS's page !
Please click here. (Japanese or English)
We build up this page wit
· Netscape Navigator 4.0
· Internet Explorer 4.0
· JavaScript : ON
· Stylesheet : ON
· Charset : EUC

Figure 1: Top page of ITLS (http://www.sci.kagoshima-u.ac.jp/~itls/)

3 Contents and Characteristics

We have named our online education system as "ITLS (Interactive Text for Learning Statistics)" which is the abbreviation of interactive text for learning statistics (URL: http://www.sci.kagoshima-u.ac.jp/~itls/). Although students can learn statistics and econometrics along this system's chapter contents, chapters are independent each other, so it doesn't matter going to their objects directly. By trying to interactive learning with this system, students can get statistical, econometrical and other economical index or knowledge depending on their own ability. An interactive and visual learning will much make possible the diversified understanding comparative with the usual learning way only by paper texts.

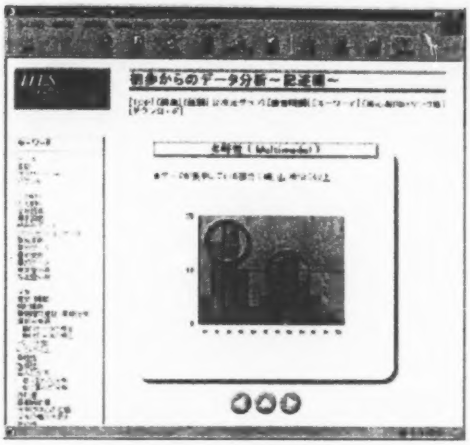


Figure 2: Descriptive statistics

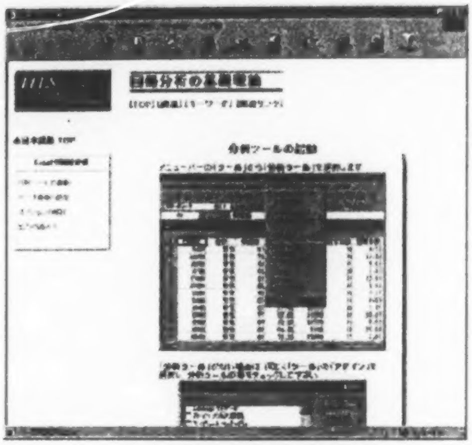


Figure 3: Regression analysis

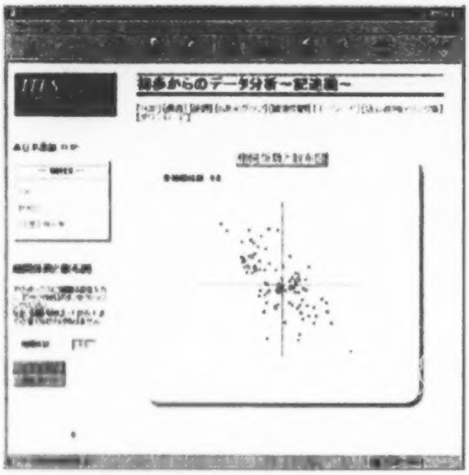


Figure 4: Dynamic graph of scattergram

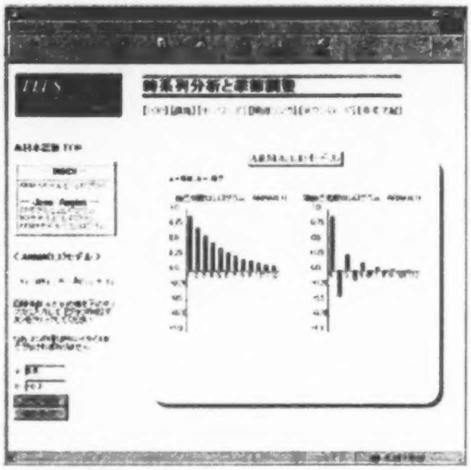


Figure 5: Dynamic graph of correlogram

Figure 2 shows multi-modal distribution in the chapter of descriptive statistics. In this chapter students can get the objective visual panel of contents by retrieving left side keywords list. There are any other explanatory panels of descriptive and inference statistics in this Web system. It is greatly more important for students to see the distribution form visually than to understand statistical concepts only without visualization. Figure 3 shows the regression analysis by familiar tool, for example, Microsoft Excel. Each chapter has used the excel or other statistical analysis software as its practical tool, at the same time in the early chapter it has been showed how to use excel as statistical analysis tool mainly. At the demonstrative step of statistics learning, it will be indispensable for students to make use of at least one statistical and analytical software tool which is not common to install in each personal computer at universities except excel.

Figure 4 and 5 show interactive statistical graph. It is not so easy for students who are majoring not scientific division to understand the relationship between graph and its fixing parameters. These styled system of viewing the dynamic change of various kinds of statistical graph have brought them both visual and intuitive understanding without mathematical formula. This interactive graph making system has been built by JAVA applet or other software tools. There are another contents such as download of lecture slides, making practices into database, setting question and answer section and online questionnaire survey of user along whose analytical results we will update our Web contents better in the future. The bulletin of question and answer is very important for all users because it is the best database of several kinds of question and its response from anyone on all sorts of questionnaire of statistical stages. Developing resources and tools also are considered very important module with which the system will be organized better hyper-linked cooperative developing environment.

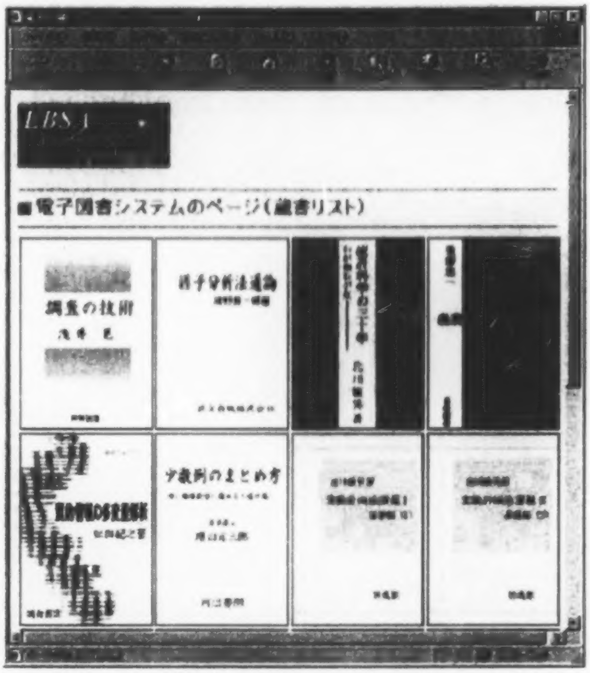


Figure 6: Top page of EBSA (http://www.sci.kagoshima-u.ac.jp/~ebsa/)

Figure 6 shows our new Web site of "EBSA (Electronic Book for Statistical Analysis)" with which everybody access to this site can do of online reading over old or new valuable books on Web. Now we have provided several important books on this site. These books open to the public under permission of the copyright holder and the publisher. Since these electronic books are scanned and transformed from real books into the PDF format files, we can download and print out all and/or selected contents of the books. Figure 7 shows one of the top page of an electronic book. Each top page contains four parts; the first and the second parts are the links to the contents and the index pages, respectively. The third part is used for keywords search. The fourth part is the print image of the real book. We rewrite these index and contents as text from the image so as to be used by keywords search.

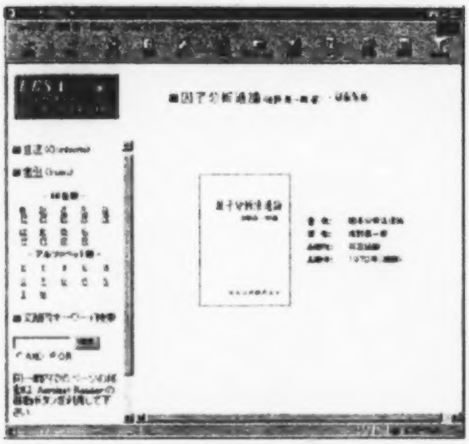


Figure 7: Top page of an electronic book

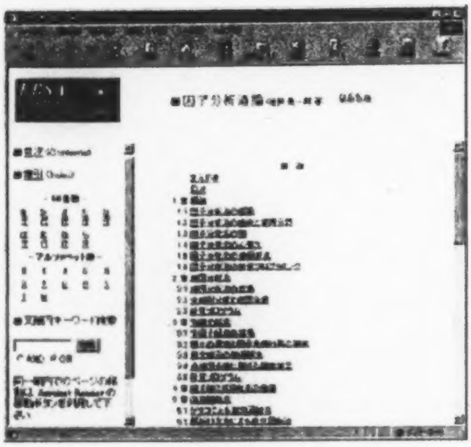


Figure 8: Contents of an electronic book

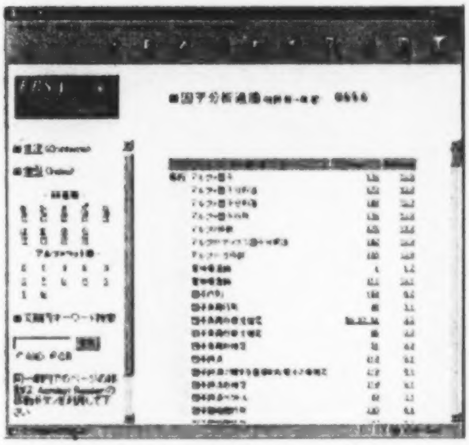


Figure 9: Index table of an electronic book

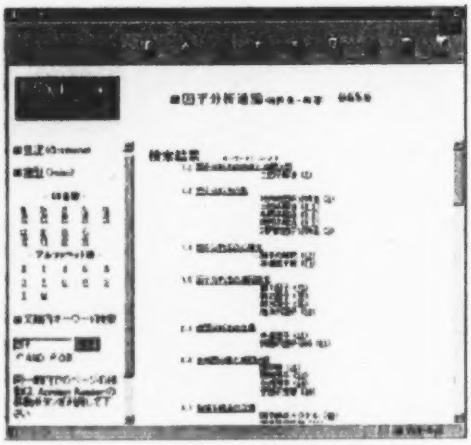


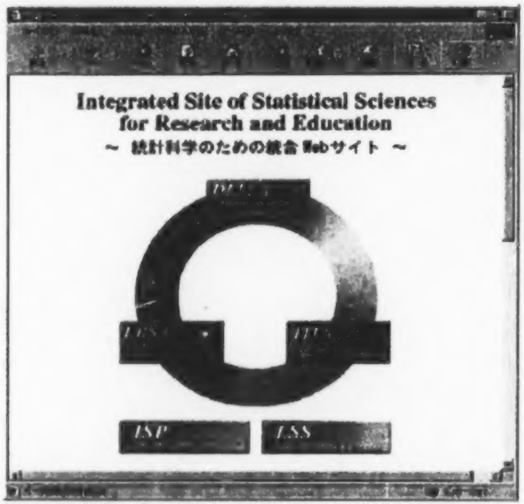
Figure 10: Result of a keywords search

Figure 8 and Figure 9 show the contents and the index table of one of the electronic books, respectively. On the contents page as Figure 8, we can read the regarding part of the book by clicking the name of the section or the subsection. On the index page as Figure 9, we can see the target page directly by clicking the index word. Figure 10 represents the result of the search by "• • •(factor)". This search system can and/or search by multi keywords. The regular expression can also be used in this system and the search can be applied to a selected book or all books in our system.

4 Effects

On students side, they can learn statistics wherever they are, at the lecture room, PC practicing room, home or any other place with Internet environment. Teachers also have the great merits. First, they can have common texts if they are under such circumstances of connecting to internet world. This site can be utilized by every faculties who are not majoring statistics. Texts will be set in the newly one whenever someone will notice another precise contents, in addition this means it would be realized the standardization of education will be led to. The best quality of texts and education will always be hoped.

Finally, we would like to introduce the integrated site of our projects. All contents discussed in this paper can be obtained from this site (URL: http://www.sci.kagoshima-u.ac.jp/~stat/).



Integrated Site of Statistical Sciences
for Research and Education
~ 統計科学のための統合Webサイト ~

Figure 12: Integrated site of our projects (http://www.sci.kagoshima-u.ac.jp/~stat/)

References

[1] de Leeuw, J., "The UCLA Statistics Textbook and Module", Bulletin of the International Statistical Institute, 51st Session Proceedings, Vol. 2, Istanbul, Turkey, pp. 55-58, (1997).

[2] Liu, L.-M., Chan, K-K., Montgomery, A. L. & Muller, M. E., "A system-independent graphical user interface for statistical software", Computational Statistics and Data Analysis, Vol. 19, pp. 23-44, (1995).

[3] Mittag, H. J., "Emphasizing Visualization and Activities in Teaching Introductory Statistics by Interactive Multimedia", Bulletin of the International Statistical Institute, 52nd Session Proceedings, Vol. 2, Helsinki, Finland, pp. 275-278, (1999).

[4] Müler, M., "Computer-assisted statistics teaching in network environments", In: Payne, R. and Green, P. (Eds.), Proceedings in Computational Statistics 98, Physica-Verlag, Heidelberg, pp. 77-88, (1998).

[5] Nakano, J., "Graphical user interface for statistical software using internet", In: Payne, R. and Green, P. (Eds.), Proceedings in Computational Statistics 98, Physica-Verlag, Heidelberg, pp. 407-412, (1998).

[6] Sakurai, N., Watanabe, M., Hashimoto, H., Yamaguchi, K. & Inoue, T., "Developing a Textbook for Learning Statistics on the Internet", Bulletin of the International Statistical Institute, 52nd Session Contributed Papers, Vol. 3, Helsinki, Finland, pp. 481-482, (1999).

[7] Sato, S., "Introduction to "Web Decomp"-Seasonal Adjustment System on WWW-", Proceedings of the Institute of Statistical Mathematics, Vol. 45, pp. 233-243 (in Japanese), (1997).

[8] Thioulouse, J. & Chevent, F., "NetMul, a world-wide web user interface for multivariate analysis software", Computational Statistics and Data Analysis, Vol. 21, pp. 369-372, (1996).

[9] West, R.W., "Statistical Applications for the World Wide Web", Bulletin of the International Statistical Institute, 51st Session Proceedings, Vol. 2, Istanbul, Turkey, pp. 7-10, (1997).

[10] Yamaguchi, K., Inoue, T., Yadohisa, H. & Watanabe, M., "Educational statistical software on the world wide web", Proceedings in Computational Statistics 98: Short Communications, Bristol, Great Britain, pp. 127-128, (1998).

[11] Aoki, S., http://aoki2.si.gunma-u.ac.jp/lecture/index.html (accessed on July 31, 2000)
[12] Abe, K., http://www1.tcue.ac.jp/home1/abek/htdocs/stat/ (accessed on July 31, 2000)
[13] Ohnishi, H., http://econom01.cc.sophia.ac.jp/ (accessed on July 31, 2000)
[14] Mittag, H. J., http://www.fernuni-agen.de/STATISTIK/ (accessed on July 31, 2000)